New Mexico

Energy$mart Technical

Standards

Low-Income Weatherization Assistance Program

January 2012

Weatherization
Works

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Acknowledgements

The details of the New Mexico Energy$mart Technical Standards were selected as best practices for the United States and adapted for the New Mexico weatherization program.

This document was written by Rick Karg with the assistance of the New Mexico Mortgage Finance Authority (MFA) and members of the New Mexico Energy$mart Technical Standards Committee.

These Standards serve as the unifying and agreed upon body of knowledge and practices required to effectively implement and evaluate weatherization for communities in New Mexico.

This is a living document that will be reviewed and updated on an annual basis based on suggestions from the New Mexico Mortgage Finance Authority, weatherization directors, and field staff throughout New Mexico.

List of names of people on standards committee:

[list of names needed here]

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Introduction

The New Mexico Energy$mart Technical Standards provide guidelines to local administering agencies regarding the proper delivery of weatherization and heating/cooling system services for residential buildings. The purpose of the Standards is to ensure that high-quality service is given at a reasonable cost and delivered uniformly throughout the State. The success of this program depends upon agencies and contractors having a full understanding of New Mexico's Energy$mart Technical Standards.

The objective of this document is two-fold. First, it serves to define the appropriate application of weatherization measures for each residence served. The manual delineates material specifications as well as the steps that should be followed to complete each measure. Alternative methods will continue to be allowed, but whatever method is used must meet or exceed the standard described in the relevant section of this document.

Second, these Standards set guides for the quality expectation of the installed product. Procedures are included for evaluating the quality of each installed conservation measure and the overall quality of the completed job.

Additionally, it is anticipated that these Standards will help ensure that weatherization program funds are used in the most cost-effective manner possible.

The Weatherization Program has changed substantially, both technically and administratively, since its inception over three decades ago. The weatherization process continues to evolve in response to changes in funding, weatherization technology, program rules, and administrative personnel. The New Mexico Energy$mart Technical Standards will be used to implement and document these changes as they occur.

These Standards are organized to easily accommodate future changes. In preparing this edition, some topics may have been inadvertently overlooked. The Standards will become more complete and comprehensive with use as omissions are identified and as new topics are addressed with new policy or guidance.

1000 General Program Requirements

1100 Effective Date

All weatherization measures performed or completed by the agencies on or after the date specified in the cover letter to these Standards shall comply with these Standards.

1200 Scope

1. The stated goal of the New Mexico Energy$mart Program (hereinafter referred to as NM Energy$mart) is as follows:

   "To reduce costs for low-income New Mexican families, particularly for the elderly, people with disabilities, and children, by improving the energy efficiency of their homes and ensuring their health and safety."

2. The New Mexico Energy$mart Technical Standards are referred to throughout this document as the "Standards."
3. The Standards shall apply to all local administering agencies (subgrantees) providing weatherization program services.
4. The Standards provide minimum guidelines for the installations of energy conservation measures and repairs. Materials and measures that are allowed or not allowed will be specifically designated.
5. These Standards are not intended to abridge safety, health, environmental, local codes, or other ordinances. Such requirements, if more stringent than these, shall apply; if these Standards are more stringent, the Standards shall apply.
6. All questions concerning the content or implementation of the Standards should be directed to the New Mexico Mortgage Finance Authority (MFA).

1300 Enforcement

An agency's continued inability or refusal to comply with applicable standards is grounds for the MFA to recommend suspension, termination, or otherwise apply special condition(s) to the agency's agreement to provide weatherization services.

1400 Amendments to Energy$mart Technical Standards

1. From time to time, the New Mexico Energy$mart Technical Standards may be amended and/or revised by the MFA to reflect changes in state and federal regulations, state-of-the-art technology, and general experience of the weatherization community.
2. Amendments to the Standards will not become effective until thirty (30) calendar days from the date of MFA approval and notification to agencies, except under the following conditions when amendments or revisions will become effective immediately:
   a. State or Federal law or regulation changes mandate immediate implementation.
   b. The MFA determines that an emergency situation exists, such as a potential threat to life, limb, or personal property, and the proposed amendment and/or revision is necessary for the protection of the health and welfare of New Mexico citizens or weatherization personnel.

3. Any agency personnel may submit comments and suggested amendments to these Standards to the Technical Standards Committee (made up of staff/members from MFA and local agencies) at any time. Suggested amendments to the Standards must be submitted in writing and should be accompanied by supporting documentation.
   a. The Technical Standards Committee shall decide to approve or deny suggested amendments within 60 days of receipt.
      i. Approved amendments shall be forwarded to MFA with a recommendation for approval. If MFA approves the suggested amendment, it will not become effective until thirty (30) calendar days from the date of MFA approval and notification to agencies. If MFA denies the recommended amendment, it shall provide a written reason to the Technical Standards Committee within thirty (30) days.
      ii. Submitters shall be informed in writing of denied amendments with a reason for the deferral. MFA shall be provided with a copy of this written deferral.

1500 *Energy$mart Technical Standards Waivers*

1. Deviations from the Standards require a waiver from the MFA Weatherization Program Manager prior to the expenditure of funds. Work may proceed after verbal authorization by the MFA Weatherization Program Manager. An electronic or hard copy documenting authorization will be forwarded and kept in the client file.
2. Waivers may be granted by MFA in the following cases:
   a. The DOE Weatherization Assistance Program does not permit the general practice on non-renewable fuel switching when replacing furnaces/appliances. However, DOE does allow the changing or converting of a furnace or appliance using one fuel source to another on a limited, case-by-case basis only.
   b. If a client/occupant refuses to allow a certain measure to be completed and this measure has a higher savings-to-investment ratio (SIR) than the remaining measures, agencies should explain the potential energy savings to the client to ensure that they understand the ramifications of their decision. Agencies must document the reason the work was not performed.
   c. To convert water heaters or heating systems to a different fuel type.
      i. Gas water heaters may be replaced with electric water heaters if it is necessary to address an unsafe venting situation, but only on a case-by-case basis.
      ii. Clients have the option of declining or waiving a conversion for personal reasons. For example, if a conversion requires that a new venting system be run through finished space and the client does not like the appearance, the client may decline the conversion.
      iii. Agencies must first educate the client regarding the advantages and disadvantages of switching fuels. If the client declines the conversion, they must sign a statement in the client file waiving the conversion.
      iv. Fuel conversions must be completed by qualified personnel in compliance with applicable building codes.

1600 *Deferral of Weatherization*

In some situations an agency or contractor should not, or may choose not to, weatherize an otherwise eligible unit. In order to handle such cases, the MFA implements the deferral policy for all agencies administering the Energy$mart Program. This policy allows weatherization staff

to postpone services when certain conditions or circumstances exist. However, an agency should define its intentions at the time a condition occurs. The agency/contractor deferral/postponement policy must contain these elements:

1. *Postponement of Weatherization Services*: An agency or contractor may postpone weatherization services under the following conditions:
   a. A dwelling unit is vacant.
   b. A dwelling unit is for sale.
   c. A dwelling unit is scheduled for demolition.
   d. A dwelling proves to be dilapidated or structurally unsound and unsafe. Dilapidated units are classified as those that do not provide decent, safe, and sanitary shelter in their present state and have defects so serious and numerous that the repairs required to restore the structure to standard condition would not be economically feasible.
   e. A dwelling unit is deemed by the auditor to pose a threat to the health or safety of the crew or contractor.
   f. A mobile home is improperly installed (for example, within adequate supports).
   g. A dwelling unit is uninhabitable (for example, a burned-out apartment).
   h. A building is affected by mold and mildew and the area affected is too large for the weatherization crew or contractor to remediate.
   i. The client is uncooperative with the weatherization agency or its contracted agent, either in demanding that certain work be done, refusing higher priority work which is needed, being abusive to the work crew or contractor, or by being unreasonable in allowing access to the unit. Every attempt should be made to explain the program and the benefits of the work. If this fails, work should be suspended and the MFA should be consulted. In such cases, documentation is required.
   j. Obvious discrepancies are found between the information supplied by the client on the application and observed conditions at the time of weatherization. The agency or contractor must resolve these discrepancies before weatherization work can continue.
   k. If, at any time prior to the beginning of work (work officially begins when the audit is performed), the agency or contractor determines that the client is no longer eligible, or personnel believe that circumstances may have changed, the unit shall not be weatherized until updated information can be obtained from the client.
   l. Rats, bats, roaches, reptiles, insects, or other animals or varmints that are inadequately or not properly contained on the premises.
   m. Health or safety hazards exist that must be corrected before weatherization services may begin including, but not limited to:
      i. The presence of animal feces and/or other excrement,
      ii. Disconnected waste water pipes,
      iii. Hazardous electrical wiring,
      iv. The presence of unsafe levels of mold or mildew, or
      v. Unvented combustion appliances or actionable levels of ambient carbon monoxide.

n. Illegal drugs are present or illegal activities are occurring on the premises.
o. The client or owner is physically or verbally abusive to any personnel.
p. The dwelling unit or parts thereof are being remodeled and weatherization work is not coordinated with a housing rehabilitation program.
q. The eligible household moves from the dwelling unit where weatherization activities and services are in progress. In such a case, the agency or contractor must determine whether to complete the work, and the circumstances must be documented in the client file.
r. One or more occupants in a dwelling have been diagnosed with a contagious and life-threatening disease.
s. When a person's health may be at risk and/or the work activities could constitute a health and safety hazard, the occupant at risk will be required to take appropriate action based on the severity of the risk. Failure or the inability to take appropriate actions must result in deferral of the weatherization work.
t. In unusual situations not covered above or where other problems of a unique nature exist, MFA should be consulted.

2. *Procedure*
   a. If an agency or contractor cannot, or chooses not, to weatherize a dwelling unit, it must notify the client or owner/authorized agent by use of the Deferral of Services Form or some other appropriate agency form or process which might include:
      i. The nature and extent of the problem(s) and how the problem(s) relate(s) to the determination not to weatherize the unit.
      ii. Any corrective action required before weatherization services can be initiated.
      iii. A time limit for correcting problems so that weatherization services may be rescheduled.
      iv. The name of the person or entity responsible for correcting the problem(s).
      v. The right of appeal.
   b. All documentation justifying the decision to postpone services must be kept in the client file.

1700 Response to Combustion Appliance Problems

1. It is often best to contact the local gas company or propane dealer to correct problems with a client's combustion appliance or heating unit. Gas utilities usually have their own emergency response protocols; these should be respected.
2. Documentation supporting the needed repairs must be kept in the client file. Repairs done under the Energy$mart Program must be included as part of the SIR calculation computed by the NEAT/MHEA audits, unless the work was done to protect the client's health and/or safety. Please refer to Section 2300 on page 9 and Section 2600 on page 12 for more information regarding in incidental repairs.

1710 Emergency Situations, Immediate Follow-up Required

Some safety problems may warrant discontinuing the combustion appliance testing or shutting off the appliance until the repairs can be made. Whenever a technician questions the safety of a situation, they should consult a supervisor. The local natural gas or

propane supplier should be called in whenever possible. Examples of this type of situation include the following:

1. *Propane or natural gas leak*: Propane can be smelled more than three feet from the leaking fitting.
2. *Clogged or disconnected flue*: A clogged or disconnected flue that cannot be fixed, causing significant spillage of combustion products into a heated space or working area of the technician.
3. *Backdrafting or significant spillage*: Any backdrafting of combustion products in combination with carbon monoxide indications that cannot be fixed.
4. *Cracked furnace heat exchanger*: Any visually identified cracked heat exchanger leaking combustion byproducts.
5. *Other hazards*: Any other situation or combination of situations that the technician or supervisor judges hazardous to the health of the client or others.

1720 Non-Emergency, One-day Follow-up Recommended

Some situations that may not warrant discontinuing testing or shutting down the heating system may be serious enough to require attention within twenty-four hours. Examples of this type of situation include the following:

1. If carbon monoxide measured in the heated space exceeds the levels listed in Sections 13850 on page 124 (gas oven testing) or 13860 on page 125 (worst-case depressurization testing).
2. Inadequate draft or spillage.
3. A furnace with no limit switch, or a limit switch that is disconnected.

1730 Non-Emergency, Five-day Follow-up Recommended

All other safety-related follow-up must begin within five days. Examples of this type of situation include the following:

1. Draft or spillage in an unheated area that does not comply with the procedures in Section 13860 on page 125.
2. A furnace limit switch that does not shut the gas off by 225°F.
3. A cracked heat exchanger is suspected, but no other apparent problems with the furnace are apparent.

1800 Monitoring by State

1810 General Procedure

1. Periodically, the MFA Program Manager or their representative Unit Inspector will conduct agency monitoring visits for the purpose of determining that all materials and services reported have been installed or completed according to the Standards.
2. The effectiveness, safety, workmanship, overall appearance, and compliance of installations with the Standards will be evaluated during the monitoring visit.
3. Dwelling units inspected may be selected by the Program Manager from a list of clients that will allow a representative sample.

4. Inspection visits may focus on problem areas identified in previous inspection reports to ensure that problems have been corrected.
5. Recommended Actions and/or Required Corrective Actions may be issued to the agency based on observations during these visits, and such guidance will be noted on a report provided to the agency. Following an inspection visit, the inspector shall review any problems/concerns that require action by the agency director.
6. If a weatherization measure or repair does not comply with the Standards and a waiver has not been issued, the expenditures for that measure might not be allowed. The agency shall have three business days to remediate any problems or concerns. Any items not corrected within three business days, or of such severity that other units may require corrective action, shall be included in a required corrective action report.
7. Deficiencies noted during State monitoring that result in Required Corrective Actions may be considered as justification for requiring that the agency re-inspect other dwellings. Please refer to Section 1820 below for the details of Required Corrective Actions.
8. A written response to Required Corrective Actions shall be submitted to MFA within 30 days detailing the completion of the corrective action.

1820 Required Corrective Action

1. Any of the following circumstances generally result in a Required Corrective Action being issued:
   a. The health and safety of clients, agency staff or subcontractors, or the integrity of the building structure is threatened by work completed with weatherization funds.
   b. A health or safety problem is created by, exacerbated by, or not corrected by the delivery of weatherization services.
   c. The omission of a required measure or technique with major energy savings potential, as determined by NEAT/MHEA, or the omission of a required procedure that addresses health and safety concerns.
   d. Poor quality of work that significantly affects the performance of measures or repairs.
   e. Expenditure of weatherization funds on measures that are not approved under the weatherization Standards or not required for health or safety reasons.
   f. Major expenditure of funds on measures that do not yield an acceptable savings-to-investment ratio as defined in these Standards.
   g. Any action or lack of action that may result in a liability that threatens MFA's financial assistance award funds.
2. A Monitoring Report that contains Required Corrective Action may result in the following actions:
   a. Disallowed costs.
   b. An increased inspection/monitoring rate.
   c. The requirement of additional training for the agency personnel.
   d. Recommendation for High Risk Status for the agency (please refer to Section 1840).
3. Continued findings of this type may result in termination of MFA funding to the agency.

1830 Appeals of Inspection Reports

An agency representative may appeal the findings of the monitoring inspection report to the Weatherization Program Manager at MFA. This appeal should be sent in writing within thirty working days of receipt of the inspection report.

1840 High-Risk Status

1. The occurrence of a substantial number of, or repeated, Required Corrective Actions may result in a decision by the Program Manager to give an agency high-risk status. Please see Section 1820 above, for an explanation of Required Corrective Actions.
2. An agency placed on high-risk status will likely have special conditions placed upon the agency's financial assistance award until the agency complies with the Standards.

2000 Energy Audits, and Final Inspections

2100 Introduction

The energy auditor plays a critical role in the success of the effectiveness of weatherization measures conducted on the home by identifying the most effective measures for energy savings. The energy auditor must provide sufficient information for the contractor or crew to work on the home, such as materials needed for the job, measures to be taken, and any specific problems or conditions the crew may encounter.

Measures to be conducted on the home are determined by visual inspections, diagnostic testing, practical considerations, calculation of savings-to-investment ratios, and the Standards.

2200 Pre-Energy Audit Requirements

Weatherization work should not be started until an agency has completed the following steps:

1. A completed application on file from the head of the household or other authorized representative.
2. Informed client of the agency's grievance policy.
3. Verified the income eligibility of the household requesting weatherization assistance.
4. Ranked the application using the priority point system.
5. Conducted an inspection of the dwelling to assess the weatherization and health and safety needs of the dwelling and determined the most cost-effective measures for the dwelling.
6. Obtained written permission from the homeowner or the landlord to work on the dwelling (Homeowner Consent Form).

2300 General Energy Audit Requirements

1. All measures installed in a dwelling must be included on the Energy Saving Economics Report, either as an energy-saving measure, a health and safety measure, or an incidental repair item.
   a. The cost of incidental repairs must be included in the cost of the bundle of measures installed in a dwelling.
   b. Service providers may be liable for repayment to the program for any measure that is not included on the Energy Saving Economics Report.
   c. The energy auditor is responsible for ensuring that all energy-efficiency measures and included incidental repairs achieve a savings-to-investment ratio of at least one.
2. Each client file must have an accurate estimate/work order (Recommended Measures Report) generated by the energy auditor responsible for the job. An acceptable work order is one for which all installed energy-saving weatherization measures have a savings-to-investment ratio (SIR) of 1.00 or greater.
   a. Measures for which SIR values are less than 1.00 are ineligible.
   b. All energy-saving measures must be considered and ranked in order of descending SIR. Installing a measure with a lower SIR without installing others with greater SIR

is not permissible; in other words, significant measures may not be skipped without a waiver from MFA.

c. It is not permissible to omit measures vital to the success of the weatherization job. For example, it is not permissible to partially insulate a dwelling because of budget constraints.

d. The input report must be included in the client file.

3. The work order must clearly itemize the work to be completed by the contractor or agency crew. The work order must have the following features:

a. Be well organized and legible.
b. Include all appropriate dimensions and quantities.
c. Include any appropriate special instructions for necessary inspections or unusual installations.
d. The method of insulation installation with the proposed amount, type, and R-Value of the insulation to be installed.
e. The name, the principals, and business mailing address of the firm providing and installing the insulation.
f. Details of any warranties on materials used in the home.
g. A written description of any work required for the installation of the insulation, including who will do the work and who will pay for it.
h. Identify any hazards at the job.
i. Include reasons for installing health and safety measures.

2400 Auditing Tools and Equipment

Please refer to Section 14000 on page 133 for a list of required and recommended tools for the NM Energy$mart Program.

2410 Equipment Maintenance

1. All test equipment used for diagnostics, evaluation, and installation of measures shall be maintained according to the manufacturer's recommendations. Required calibration and maintenance includes the following:

a. Calibration of electronic equipment, including, but not limited to:

i. Instruments for measuring carbon monoxide.
ii. Instruments for measuring combustion efficiency.
iii. Equipment for measuring electrical consumption.
iv. Digital manometers.

b. Recommended maintenance of mechanical equipment and electric motors, including, but not limited to:

i. Blower door fans.
ii. Manometers.
iii. Insulation blowing machines including their motors, hoses, seals, and filters.

2. Agencies should develop and adhere to an equipment maintenance schedule for equipment used by energy auditors.
3. Contractors should develop and adhere to an equipment maintenance schedule for equipment used for weatherization program work.

4. MFA will monitor the service provider's equipment maintenance procedures and logs during either inventory or technical monitoring.

2500 *Energy Audit Requirements*

1. The energy audit must include the following minimum information and inspection and testing results:
   a. The date the energy audit was run. Under no circumstance should the audit have a date other than the actual date it was run.
      i. An audit that is re-run shall have a different date than the initial energy audit.
   b. Information about the existing condition of the dwelling and its mechanical systems, including heating and cooling systems.
   c. Diagnostic tests including the following:
      i. Combustion appliance analysis of steady-state efficiency.
      ii. Forced air furnace assessment including the following inspections and tests:
         1. Visual ductwork inspection.
         2. Dominant duct leakage test.
         3. Room-to-room pressure balance test.
         4. Pressure pan testing, as required by these standards.
      iii. Furnace heat rise and static pressure testing.
      iv. Combustion safety testing, including the following:
         1. Combustion appliance zone depressurization. Carbon monoxide shall be tested at worst-case depressurization in the vent connector; draft shall be measured in the appropriate location in the vent connector; and a spillage test shall be done. See Section 13860 on page 125.
         2. Testing of gas ranges. See Section 13850 on page 124.
         3. Checking for gas leaks. See Section 13830 on page 124.
      v. Blower door testing, including the following zones:
         1. Whole-house test to find CFM_{50} and determine integrity of the air barrier.
         2. Attic thermal bypass assessment.
         3. Leakage from tuck-under garages.
         4. Leakage from attached garages.
         5. Leakage from attic spaces.
         6. Leakage from crawlspace or basement.
         7. Leakage from any space containing possible contaminants.
   d. Health and safety problems including possible lead paint, moisture and/or mold, electrical problems, signs of rust and corrosion on combustion appliances. The Health and Safety Inspection Check List must be filled in and signed by the client.
   e. Existing insulation levels. R-values for fiberglass should be adjusted according to Section 6220 on page 48.
   f. Conditions the contractor/work crew needs to know in advance.
   g. Dwelling evaluation considering existing conditions for energy savings opportunities and related health and safety problems.
   h. Identification of appropriate air and thermal barriers.
   i. Moisture problems.

j. Baseload energy usage including a record of the last twelve months of utility bills data.
k. Client energy usage problems.
l. Indoor air quality (IAQ) assessment including ventilation for acceptable IAQ and the following air quality measures:
   i. Identification of potential contaminant sources.
   ii. Measurement of existing exhaust fan flow rates.
   iii. Determination of ASHRAE 62.2-2010 minimum whole-house ventilation rate.

2. Work orders must effectively communicate to the contractor/work crew sufficient information on the home and measures to be taken. The work order should include the following information:
   a. Particular problems or considerations crew needs to know in advance.
   b. Total costs and for all proposed measures.
   c. Estimate of the time to complete the work.
   d. Analysis of warehouse inventory as it relates to the job, if applicable.
   e. Analysis of whether utility funds (for example, PNM and NM Gas) will be used for certain measures, if applicable.

2600 *Allowable (Incidental) repairs*

1. At the beginning of every program year, each agency must provide to MFA a list of items they wish to include as incidental repairs. The following items are allowed:
   a. Sealing of cracks.
   b. Caulking and weatherstripping.
   c. Installation of door sweeps.
   d. Repair and replacement of thresholds.
   e. Repair and replacement of fireplace dampers.
   f. Repair or replacement of broken glass.
   g. Replacement of exterior doors, but only if the existing door cannot be repaired.
   h. Door repair.
   i. Repair of building envelope to maintain the integrity of weatherization measures.
2. Costs for incidental or necessary repairs are allowable if they protect the integrity of the installed weatherization materials. Supporting documentation is strongly encouraged when any repairs are made. Incidental repair costs are to be included in the savings-to-investment-ratio calculations for the related measure.
3. Costs for incidental repairs must be included in the cost of the bundle of measures installed in a dwelling.

2700 *Computerized Energy Audit*

New Mexico Energy$mart Program uses the Weatherization Assistant software as its energy audit tool. Other computerized energy audit tools may be used with the approval of MFA.

The Weatherization Assistant energy audit software was developed by Oak Ridge National Laboratory specifically for the use for the Weatherization Assistance Program. The Weatherization Assistant software has two components: the National Energy Audit Tool (NEAT) for single-family houses and the Manufactured Home Energy Audit (MHEA) for mobile homes.

1. Values and methods used in NEAT/MHEA will be periodically updated by either the agency or statewide weatherization committees as follows:
    a. Costs shall include fringe benefits as defined by the agency's accounting system.
    b. Insulation cost estimates must be based on at least the manufacturer's recommended minimum installation density.
    c. Cost estimations used for the approved audit must be updated at least once each year and procedures used to derive these estimated costs must be documented by the agency.
    d. A technical committee, made up of representatives from all the State agencies, will update the following each year:
        i. The typical service life of each energy-saving measure. The service life values must be discounted for use in the calculation of SIR in accordance with Department of Energy guidelines.
        ii. A consistent method determining the cost of fuels to be used in NEAT/MHEA.

2800 *Required Client File Documentation*

Documentation for each completed client file must contain the following documentation:

1. Input report for the energy audit.
2. Documentation of the initial audit, including the auditor's name and the date of the initial energy audit.
3. Permission Form. This must be explained to the client by the energy auditor and signed by the client and the auditor.
4. Work Order. This must be filled out by the energy auditor.
5. A copy of the NEAT or MHEA "Recommended Measures Report".
6. Accurate records or documentation of all installed measures and their costs. Costs must include the labor used to install the measure.
7. Each client file must include documentation of all efficiency work and adjustments made to the water heating, heating combustion appliances, and space cooling appliances, when applicable.
8. Information on the applicable combustion appliance efficiency tests and components.
9. Pre- and post-weatherization blower door test information in units of CFM_{50}.
10. A complete record of the pressure diagnostics tests performed, if appropriate.
11. New Mexico State Historic Preservation Office (SHPO) Form. This form – Section 106 Checklist – must be filled out by the energy auditor.
12. Copies of required permits for the work.
13. The final inspection forms, signed and dated by the client and the final inspector, attesting that the work is complete and satisfactory. The inspection, when practical, should be performed within fourteen (14) calendar days of work completion.
14. Copies of the letter of condemnation of combustion systems and the permit to install a replacement (if required).
15. Waivers and explanations:
    a. Approved waivers, when applicable.
    b. An explanation of reasons that any dwelling unit did not have a blower door test performed.
    c. An explanation for reasons that any weatherization measures with a SIR greater than 1.00 were not installed.
    d. A list of any conditions that are judged to be out of the ordinary.
    e. Lien wavers.

16. Client Information:
    a. A signed weatherization application.
    b. Brief documentation indicating that owners and clients were notified of any potential or current health or safety problems that necessitated deferral of weatherization work.
    c. A copy of an executed landlord/tenant agreement if the weatherized dwelling is rental property.
    d. A completed Homeowner Consent Form.
    e. The pamphlet, "Renovate Right: Important Lead Hazard Information for Families, Child Care Providers and Schools" must be distributed. Please see Section 41200 on page 29, Lead Safe Weatherization (LSW), for more information.

2900 Final Inspection Procedures

The Department of Energy and New Mexico MFA require that final inspections be performed by agencies to assess adequacy and quality of work. The DOE rule reads as follows:

"No dwelling unit may be reported to DOE (or New Mexico MFA) as completed until all weatherization materials have been installed and the agency or its authorized representative, has performed a final inspection(s) including any mechanical work performed and certified that the work has been completed in a workmanlike manner and in accordance with the priority determined by the audit procedures required by 440.21. . ."[1]

The final inspection must be performed by a certified agency energy auditor on all the dwellings weatherized. The purpose of the final inspection is to ensure that the work has been completed in a workmanlike manner and in accordance with the NEAT or MHEA energy audit and the work order.

The final inspection for each weatherized unit shall be performed by the agency, or an approved authorized representative, within 14 working-days of the final day of weatherization work being completed by agency crew(s) or contractors.

Any agency member, contractor, or representative who performs weatherization retrofits on units may not serve as the inspector for any completed unit within three months of the individual's last day completing weatherization retrofits. Energy auditors, or assistants, may serve as completed unit inspectors unless they have installed weatherization retrofits within the preceding three months or have participated in the energy audit process of the unit to be inspected.

The final inspector may perform minor adjustments to previously installed retrofits in order to attain satisfactory inspection results. Such adjustments must not exceed one working hour per unit and will not be considered a "weatherization retrofit" as noted above.

The following tests and inspections must be performed during the final inspection:

1. Quality and quantity of materials installed, including verification that all measures on the work order have been installed and work has been completed as intended.
2. Review of the input report for quality control.

[1] *U.S. Department of Energy - Weatherization Assistance Program for Low-Income Persons - Title 10, Part 440, Final Rule* - Revised as of December 8, 2000, section 440.16.(5).(g).

3. Installation standards/work quality.
4. A post-weatherization blower door test to verify reported post-weatherization CFM_{50} value.
5. Health and safety tests, including combustion safety tests (refer to Section 13800 on page 123 for required combustion safety tests)
6. If duct sealing was performed, inspection must also include the following:
    a. Visual ductwork inspection.
    b. Dominant duct leakage test.
    c. Room-to-room pressure balance test.
    d. Pressure pan testing.
7. Furnace heat rise and static pressure testing
8. Completion of the Weatherization Final Inspection Form.
9. Client signature(s) verifying completion of work.

2910 General Requirements – Quality of Work

1. At no time during the job shall the agency crew or contractor store any materials and tools in living areas of the dwelling. Tools and materials shall be placed in proper storage chests or job trailers at the end of each workday.
2. Any exterior wood trim installed on the home should have all six sides primed. Care shall be taken to assure that the new trim blends into the existing character of the home and is of equal or better quality.
3. Any interior materials installed on the home should be of a material to match the existing trim located in the home.
4. All materials being installed by the agency crew or contractor shall be installed to closely match the existing trim or finish material that is adjacent to the new installed trim.
5. Building permits, electrical permits, plumbing permits and other permits required by local or State authorities shall be obtained by the agency crew or contractor. Permits must be obtained prior to commencement of work.
6. Workmanship and materials not covered by manufacturers' warranties shall be warranted by the contractors for a period of at least one year from date of final payment to the contractor. All manufacturers' warranties shall be delivered by the contractor to the agency for inclusion in the final job packet.
7. All repair work shall conform to the local building codes when applicable. Where applicable, repair work completed shall also conform to the appropriate local and State codes.

2920 General Final Inspection Items

1. The inspector is responsible for ensuring all items specified in the work order have been completed in a professional manner.
2. The inspector shall assess the job to ensure that the agency crew or contractor have not damaged any existing finishes and items in the home.
3. The inspector shall also ensure that the contractor or crew have left the dwelling in a clean and orderly manner.

4. The work order and applicable rework(s) shall be followed at all times during the final inspection and any items that have not been completed to the satisfaction of the inspector must be noted on an agency Rework Order.
5. Any required rework shall be completed in a timely manner and must be verified by the original inspector.
6. If a Rework Order is issued, the inspector must return to the dwelling for another inspection after the rework has been completed.
7. The inspector is responsible for obtaining all the proper homeowner signatures on the final sign-off for the project.
8. All required paperwork must be placed in the client file.
9. In the case of client or scheduling obstructions to final inspection, additional documentation must be provided:
    a. New Mexico MFA recognizes that in some cases it may be impossible to complete a final inspection of the dwelling unit, even after repeated efforts to schedule the inspection. In these cases, the agency must document that an inspector made a significant effort to inspect the dwelling after completion of the weatherization work. At a minimum, a visual inspection of any exterior weatherization measures must be completed.
    b. Documentation regarding attempts to contact must be put in the client file, signed by the inspector and the agency weatherization director, indicating the dates when the agency attempted to inspect the residence.
        i. The agency should notify the client in writing explaining that the agency was unable to complete a full on-site inspection.
        ii. If the client does not respond within two weeks, the agency should contact New Mexico MFA for documented approval to report the unit as a completion.
10. After all work on the dwelling has been completed and approved by the inspector, the inspector must sign and date the Weatherization Final Inspection Report. His or her signature certifies that the dwelling has been inspected, that the work was satisfactorily completed and that all materials charged for were properly installed.
11. No dwelling unit may be reported to New Mexico MFA as a completed unit until the administering agency has performed a final inspection and certified that applicable work has been completed in a workmanlike manner and in accordance with the procedures established for the New Mexico Energy$mart Program. Any dwelling presented to New Mexico MFA that has not had post-inspection can constitute contract breach and non-compliance by the agency.

3000 Client Education

Changing occupant behavior is key factor in improving the energy consumption of a dwelling. For example, when household members become aware that their choices for thermostat settings, hot water usage, and switching off unused electrical devices can reduce their energy bills, they are motivated to develop and maintain energy-saving habits.

The energy auditor (or other weatherization staff person) should discuss with clients only those topics that are relevant to their dwelling. Additionally, clients should be informed and educated to a level that is appropriate and understandable.

Always fill out and have the client sign the "client education checklist". Include a copy in the client file.

3100 Client Education Recommendations

1. Client education should be provided during all phases of the weatherization process. This includes, but is not limited to the following steps:
    a. During client intake and scheduling, explain the following:
        i. What the client should expect.
        ii. How the weatherization process will proceed.
        iii. Who will call next?
    b. During the initial field inspection, discuss the following:
        i. What the client should expect during the energy audit.
        ii. Air leaks discovered with the blower door.
        iii. Any health and safety issues, such as:
            1. Lead paint.
            2. Asbestos.
            3. Combustion venting.
            4. Carbon monoxide.
            5. Mold and mildew.
            6. Plumbing leaks.
            7. Animal hazards such as rodent feces or insect infestations.
            8. Electrical hazards.
            9. Other possible hazards.
        iv. Health and safety issues should be addressed both verbally and by distributing educational pamphlets during the audit "walk-through." This can be particularly effective as the auditor notices and discusses potential hazards.
        v. Energy conserving measures that will be installed, such as:
            1. Air sealing.
            2. Additional insulation.
            3. Heating system improvements.
            4. Air conditioning improvements.
            5. Baseload reduction measures, including water heater improvements.
            6. Low-flow plumbing fixtures (shower head or aerator). If one is installed in conjunction with lowering the domestic hot water temperature, the chances are high that the client will not notice

less hot water for showering, as they might if the temperature is reduced without installing the new showerhead.

vi. Improvements in the thermal comfort of the dwelling as a result of the weatherization.

vii. An explanation of gas range safety and proper use. Refer to Section 13840 on page 124.

viii. An explanation of required maintenance for existing equipment, added equipment, or energy-saving measures.

ix. What will take place after the initial inspection:
   1. Schedule of events.
   2. Who will contact the client next?
   3. When the work will be complete.

x. Work the client must do to prepare for the weatherization:
   1. Moving stored items to make room for the weatherization work.
   2. Any other actions that must take place before the weatherization work begins.

c. Health and Safety
   i. CO Poisoning and CO alarms.
   ii. The client must be informed by the weatherization staff regarding:
      1. How CO poisoning occurs.
      2. How the alarm operates, including the expected life of the alarm, after which time they will be responsible for replacement.
      3. The dangers of chronic low levels of CO (i.e., from 5 to 70 ppm CO) for those people with respiratory problems, the elderly, young children, and pregnant women.
      4. What to do if the alarm sounds (see below).
   iii. If the CO alarm sounds, or if the client has observed continuous readings below the level that activates the alarm:
      1. Recommend that they call their heating contractor or fuel provider to examine their appliances, as this level is an indication of problems with the combustion appliances and poses a health risk to people vulnerable to low-level exposure.
      2. If the detector sounds, the client should assess the situation quickly for potential causes for the alarm.
      3. If it is determined that there is a problem after the first or second alarm, the client should call the local fire department and move to the outdoors immediately. If the alarm sounds, it means the levels of CO have reached a dangerous level and immediate action is required to ensure their safety. Refer to the manufacturer's instructions.

d. The installation and repair of conservation measures.
   i. Those installing weatherization measures should always take advantage of client education opportunities, if feasible. Such opportunities may include explaining how and why a measure is being installed and how the measure may reduce the client's energy bill and improve their comfort.

e. Window air conditioners. When it is found that the client does not remove a window air conditioner for the heating season, client education should address the advantages of:
   i. Removing and closing the window, or

ii. Installing an airtight cover on the exterior of the air conditioner unit, or
iii. Sealing the air conditioner unit from the interior.

f. The final job inspection.
   i. The inspection personnel should reinforce the advantages of the energy-saving measures installed.
   ii. The client should always be asked if they have any remaining questions regarding the weatherization or health and safety work that was done.
   iii. Inspection personnel should explain to the client how the dwelling will perform differently as a result of the installed weatherization measures.

g. Whenever possible, demonstrate to educate. Get the client involved in the educational process, if possible. The use of up-to-date written materials is encouraged, but demonstration has proven to work better in most cases.

4000 Health and Safety Requirements

4100 Introduction

An important goal of New Mexico's Energy$mart Program is to implement cost-effective weatherization procedures to conserve energy and to assess and correct related health and safety hazards for the well-being of clients, their dwellings, and weatherization personnel.

The weatherization assistance provided by local agencies and contractors has the potential to affect the operation of, and the interaction among, the various "systems" within clients' homes. It is therefore important that agency and contractor staff remain aware of the potential hazards associated with the weatherization process and not compromise the integrity of client safety or the building when installing weatherization measures.

While the primary purpose of the NM Energy$mart Program is to reduce energy use in low-income dwellings, it is necessary on occasion to make related repairs and to mitigate health and safety concerns which may not result in a decrease in energy use or in monetary savings. Therefore, as part of the NM Energy$mart Program, the following health and safety standards have been developed with the objective of providing general guidance to agencies and subcontractors doing work within the program. All persons providing services under this program shall be governed by these requirements.

Health and safety measures which do not result in a decrease in energy use and do not save the client any money will be allowed when the measured must be taken in order to effectively perform weatherization work or the measures are necessary as a result of weatherization work in order to protect the health and safety of the dwelling occupants. Approval from MFA shall be requested where required.

It is the responsibility of the agency to manage health and safety expenditures. Health and safety costs must be excluded from any SIR calculations and the per unit average and must be tracked separately. Any health and safety measures that result in energy savings do not have to be tracked separately and should be included with the energy conservation measures. Any non-cost-effective tested health and safety measure should be reported separately.

Each home weatherized must be individually assessed to determine the existence of potential hazards to weatherization personnel or clients. When conditions within the home will jeopardize the health and safety of the client, crew, or subcontractor prior to providing assistance, weatherization must not proceed until such problems are remedied. In some cases, mitigation of problems may be beyond the scope of the weatherization program. In these instances, the client must be notified in writing and referred to alternative resources for resolution of the problem.

In those instances where the existing conditions are pose a perceived threat to the crew or contractor's health and safety, the NM Energy$mart Program allows *technical waivers* for any audit or inspection process, installation, or any portion of the weatherization activity.

Under these Standards, health and safety assessments of the following must be performed:

1. Hazardous conditions and materials assessment, including, but not limited to:
   a. Friable asbestos.
   b. Unsafe levels of combustion byproducts, including carbon monoxide.
   c. Human or animal waste within the occupied dwelling.
   d. Unsafe and excessive levels of chipping and peeling lead paint in pre-1978 homes. This is of particular concern on interior surfaces and components.
   e. Mold or mildew.
   f. In homes where radon may be present:
      i. Provide the client with EPA's consumer guide to radon.
      ii. Whenever conditions permit, exposed dirt must be covered with a vapor permeable ground cover.
      iii. In dwellings where radon may be present, precautions should be taken to reduce the likeliness of making radon concentrations higher.
      iv. Radon mitigation is not required by DOE.
      v. Radon testing is not an allowable DOE expense.
2. Air quality assessment, including:
   a. Interviewing client(s) regarding health conditions of occupants with the intent of determining if air quality is unacceptable.
   b. Determination of ventilation needs for ensuring acceptable indoor air quality. Mechanical ventilation requirements shall be based on *Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings*, ASHRAE Standard 62.2-2010.
3. Combustion systems assessment, including:
   a. Combustion safety testing, including worst-case depressurization spillage, draft, and carbon monoxide testing in appropriate dwellings before and after weatherization work. Additionally, it is required that worst-case depressurization testing be conducted while the work is being done, just before the crew or contractor leaves the job site for the day.
   b. Fuel storage and fuel distribution hazards, including oil tank or propane storage problems and oil, propane, and natural gas distribution line leaks.
   c. Hazardous combustion appliance conditions.
4. Assessment of crew, contractor and client safety concerns.
   a. All materials stored on the job site for weatherization work must be stacked, organized, and properly marked so that they do not pose hazards to clients, neighbors or weatherization personnel.
   b. All weatherization work must be performed in a manner that does not create a known hazard to clients, neighbors, or weatherization personnel.
   c. For pre-1978 homes where lead testing has been completed and lead is found to be present, all weatherization work must be performed by weatherization personnel certified lead-safe work practices.

5. Reclaim any refrigerants using procedures of the Clean Air Act 1990, section 608, as amended by 40 CFR82, May 14, 1993.

4200 General

1. Correction of pre-existing code compliance issues is not an allowable cost other than where weatherization measures are being conducted. State and local codes must be followed when installing weatherization measures.
2. Correction of fire hazards is allowed when necessary to safely perform weatherization.
3. Pest removal is allowed only where infestation would prevent weatherization.
   a. Infestation of pests may be cause for deferral where it cannot be reasonably removed or poses health and safety concern for workers.
   b. Screening of windows and points of access is allowed to prevent intrusion.
4. Removal of pollutants such as formaldehyde, volatile organic compounds, and other pollutants is required if they pose a risk to workers. If these pollutants pose a risk to workers and removal cannot be performed or is not allowed by the client, the unit must be deferred.
5. In dwellings were radon may be present, precautions should be taken to reduce the likeliness of making radon concentrations higher. For example, wherever conditions permit, exposed dirt must be covered with an impermeable ground cover (except for mobile homes).
6. Repair and replacement of solid-fuel burning appliances is allowed when client health and safety is a concern.
   a. Providing fire extinguishers is allowed only when solid-fuel burning appliances are present.

4210 Homeowner Consent Form

Instances when health and safety problems might remain after weatherization has been completed on a dwelling may include the following:

1. Repairs relating to combustion appliances that are too extensive or costly for the New Mexico Energy$mart Program to remedy. (An example is an aged, asbestos-covered boiler.)
2. Existing conditions in a dwelling that are beyond the control of the weatherization agency. (Examples include the client use of unvented kerosene or gas space heaters as a secondary heat source.)

The Homeowner Consent Form is to be used to document existing potential health and safety problems that remain after the weatherization work is completed.

1. An agency representative must explain the problems to the owner and, in the case of a rental unit, the client.
2. The health and safety problem(s) and corrective measures the owner and/or client can take must be documented on the form with as much detail as possible.
3. The owner and agency representative must sign and date the statement.

4. A copy of the form must be given to the client/owner.

4300 *Client Health and Safety*

1. Weatherization services must be provided in a manner that minimizes risk to clients.
2. Health and safety issues should be addressed as part of the client education process, both verbally and by distributing educational pamphlets (when available) during the audit "walk-through." This can be particularly effective as the auditor notices and discusses potential hazards.
3. Dwellings with unvented (vent-free) combustion appliances used as a primary heat source, with the exception of gas ranges, may not be weatherized until such appliances are properly vented to the outdoors (according to the appropriate code) or removed. Refer to Section 8430 on page 78 for more information.
4. Building owners and clients must be notified of any health or safety problems that require terminating the weatherization work. Documentation of this notification must be included in the client file.
5. It is preferred that agencies minimize or restrict the use of materials that may be hazardous to the client; however, if the agency must use hazardous chemicals, it must be discussed with the client prior their use.
6. Special precautions must be taken if the occupant of the home has respiratory ailments, allergies, is pregnant, or has unique health concerns.
7. Agencies should try to protect all clients from respirable particles, such as paint or insulation dust, during the weatherization process.
8. The installation of hazardous materials must be done in well-ventilated areas.
9. Weatherization personnel shall not smoke cigarettes, cigars, or pipes in a client's home or outdoors within 25 feet of the client's home.
10. If strong smelling chemicals, such as formaldehyde, are detected in the client's home, agencies should not perform any weatherization measures that would reduce the natural air leakage of the dwelling unless mechanical ventilation is present or installed.
11. At a minimum, auditors and weatherization personnel should inform property owners of safety problems, code problems, and other health and safety issues including the following:
    a. Hazardous levels of carbon monoxide.
    b. Raw sewage leaking from waste plumbing pipes.
    c. Mold and moisture.
    d. Friable asbestos.
    e. Radon gas.
    f. For lead safe weatherization requirements, please see Section 41200 on page 29.

4310 Injury Prevention for Occupants

1. Minor repairs may be done when weatherizing a home in order to prevent injury to weatherization workers during weatherization and to occupants. These repairs may only be done to the extent of ensuring safety. These minor repairs might include the following:

a. Replacing missing light bulbs.
b. Lowering domestic hot water temperature.
c. Repairing stairs, replacing handrails, and installing grab bars.
d. Repairing decks and balconies.

4320 Preexisting Occupant Health Condition

When a person's health may be at risk and/or the work activities could constitute a health and safety hazard, the occupant at risk will be required to take appropriate action based on the severity of the risk.

1. The at-risk occupant should reveal they known or suspected heath concerns during the initial application for weatherization services.
2. The at-risk occupant should be provided with known risks of the weatherization process.
3. Worker contact information should be provided to the occupant so that occupant can easily provide information about health issues or concerns.
4. Failure or the inability to take appropriate actions must result in deferral of the weatherization work.

4400 Agency Health and Safety

1. When in doubt, agencies should seek consultation services from an OSHA subsidized professional safety consultant (See: OSHA Publication # 3047, Consultation Service for the Employer) for identifying hazards and developing a worker health and safety program.
2. Agencies must have an approved Health and Safety Policy in place to protect worker health and safety.
3. The Health and Safety Policy should specify the following information:
    a. That Material Safety Data Sheets (MSDS) must be on the job site and available to medical personnel.
    b. Where employees should to go for treatment.
    c. A written procedure for reporting medical emergencies.
    d. A written procedure for reporting non-emergency accidents.
    e. How to provide prompt medical attention for serious injuries.
    f. How to provide prompt transportation or contact an ambulance in the case of a serious emergency.
    g. That telephone numbers of physicians, hospitals, or ambulances should be conspicuously posted.
    h. That a first aid program including the following should be in place:
        i. First aid training provided to at least one member of each crew/contractor.
        ii. CPR training provided to at least one member of each crew/contractor.
        iii. One complete first aid kit per vehicle.
        iv. One eye-wash station with at least one refill per vehicle.
4. Agencies must establish a Personal Protective Equipment Program. This program should include the following:
    a. Respiratory Protection Procedures that provide employees with the following:
        i. The proper personal respiratory protection equipment.

ii. Respirator fit testing, by a trained person.
iii. Training to employees on respirator use.
iv. Medical examination of pulmonary capacity with a frequency recommended by appropriate OSHA standards.

b. Eye protection should be made available when appropriate.
c. Gloves and protective coveralls should be made available when needed to protect worker health or safety.

5. Agencies should have in place a Tool Safety Program designed to protect employees from work place hazards. This program should ensure the following:
   a. Tools are safe and adequate for the job.
   b. Ground-fault protection is provided for power tools.
   c. Employees are trained in the safe and proper operation of tools and equipment used in their work.
   d. Safety guards are in place on all tools that come equipped with such devices.
   e. Ladders and scaffolding are adequate for use, have the proper weight rating, and are constructed of non-conductive material.
   f. That hearing/ear protection is provided to individuals working around high decibel equipment or in high dust environments.
6. It is preferred that the agencies have a Fire Protection Program. This program should include the following:
   a. Fire extinguishers are provided:
      i. Located in the agency offices and warehouse.
      ii. Located in each vehicle.
      iii. Inspected regularly.
   b. Training on fire extinguisher use.
   c. Fire emergency procedures.
7. It is preferred that agencies have a Job Hazards Identification Program. This program should include the following:
   a. Investigation of job-specific safety hazards.
   b. Hazard Communication Procedures that include the following:
      i. Written policies for dealing with job hazards.
      ii. All hazardous materials containers labeled with the following:
         1. Hazardous chemical contents.
         2. Hazard warning appropriate for employee protection.
         3. Legible and prominent labels on all containers.
      iii. Means of communication for non-routine tasks and unlabeled chemicals.
      iv. A means for the exchange of information between agencies and sub-contractors regarding hazardous materials.
   c. A catalog of Material Safety Data Sheets (MSDS) for all hazardous material that is made available to all employees, kept on file at the agency offices, and posted on all jobs sites. The MSDS catalog should contain the following for each hazardous substance:
      i. Chemical and common name.
      ii. Physical and chemical characteristics.
      iii. Known acute, chronic and related health effects.
      iv. Precautionary measures.

v. Exposure limits.
vi. Identification of carcinogens.
vii. First aid procedures.

d. Implementation of a Hazardous Material Communication Policy. Such implementation should include the following:
   i. Information on where hazardous materials are located and where they are used.
   ii. Employee information and training on hazardous materials.
   iii. Training conducted at the time of initial assignment or whenever a new hazard is introduced to the work environment.
   iv. How to read and interpret labels and MSDS.
   v. How to obtain and use information on the hazards of a chemical and how to implement protective measures.

e. A Hazardous Chemicals List that is made available to employees.

f. Written hazard evaluation procedures for agencies.

g. Written materials on workplace hazards for agencies.

4500 Combustion Appliances and Heating Systems

1. Repair and replacement of inoperable or unsafe combustion appliances is allowed, including the installation of direct-vent, sealed-combustion appliances.
   a. Repair and cleaning should be done before replacement is considered.
   b. Proper venting to the outdoors, including gas dryers and range hoods, is required.
      i. Correction of venting is allowed when testing indicates a problem.
2. System repair, replacement, or installation is allowed for red-tagged, inoperable, or nonexistent heating systems where climate conditions warrant.

4510 Water Heaters and Other Appliances

1. Poorly functioning water heaters that may pose a health concern may be replaced on a case-by-case basis.
   a. Installation of one per dwelling is allowed.
   b. Documentation must be maintained to justify replacement.
   c. Replacement and installation of other appliances for health and safety reasons is not allowed. Repair and cleaning are allowed.

4600 Air Conditioning Systems

Air conditioning system replacement, repair or installation is allowed in homes of clients at risk of health problems from high-temperature conditions where climate conditions warrant.

4700 Biologicals and Unsanitary Conditions

Remediation of a condition that may lead to or promote biological concerns or unsanitary conditions is allowed; however, addressing bacteria and viruses is not an allowable cost. Deferral may be required in cases where a known biological agent that may create a serious risk to weatherization workers is present in a dwelling.

4800 Stand-Alone Electric Space Heaters

Repair, replacement, or installation of stand-alone electric space heaters is not allowed.

1. Check the electrical circuitry to ensure adequate power for existing space heaters.
2. Inform client of the hazards of use and have client sign a waiver if removal is not allowed by the client.
3. Removal is recommended. (*Stand-alone electric space heaters may be used as a temporary heat source during weatherization if the primary heating system is disabled.*)

4900 Spray Polyurethane Foam Use

Spray polyurethane foam is a widely used and highly-effective insulator and sealant; however, eye, skin, and inhalation exposures to its key ingredients can cause asthma, lung damage, other respiratory problems, skin and eye irritation, and other adverse health effects.

1. When working within the thermal envelope with spray urethane foam, follow the EPA guidelines[2] or manufacturer's guidelines.
2. When using spray urethane foam outdoors, isolate the area where the foam will be applied, take precautions to ensure the fumes will not be transferred to the indoor living area.
3. Make sure all State and local fire codes are followed when spray polyurethane foam is used indoors.

41000 Miscellaneous Health and Safety Rules

1. Replacement, repair or installation of windows or doors is not an allowable health and safety cost but may be allowed as an incidental repair or an efficiency measure if justified by the NEAT or MHEA audit.
2. Replacement, repair, or installation of telephones is not an allowable cost. (Provide client information about telephone replacement programs.)
3. Vented space heaters should be treated as normal heating systems and should be tested in a manner similar to central furnaces.
4. Repair and replacement of solid-fuel heating appliances is allowed only when client health and safety are a concern. Refer to Section 8470 on page 81 for more information.

41100 Asbestos Inspection Procedures

1. Because weatherization testing or work may potentially disturb materials containing asbestos, the energy auditor must inspect for such materials prior to beginning work.
2. Decisions on approaches to weatherization work where asbestos is present shall be based on the judgment of the most qualified individual available to the agency.
3. When major energy-saving measures might be sacrificed as a result of suspected asbestos-containing materials, the agency should have the suspected material tested for asbestos content.

[2] Please see http://www.epa.gov/dfe/pubs/projects/spf/spray_polyurethane_foam.html for detailed information.

4. All agency workers must wear high-quality respirators any time they work with asbestos.
5. When working with materials containing asbestos, the materials should be dampened with water whenever possible to reduce the risk of airborne asbestos fibers.
6. Materials containing asbestos may not be cut, drilled, or disturbed in any manner that may cause asbestos fibers to become airborne.
7. Removal of asbestos siding is allowed when performing energy-saving measures. All precautions must be taken not to damage the siding. The siding should never be cut or drilled. It is recommended, where possible, to insulate through the interior walls.
8. On covering materials, such as steam pipe insulation, assume asbestos is present. Abatement – either removal or encapsulation – is allowed by a certified asbestos abatement contractor.
9. When vermiculite insulation is found in an attic take precautionary measures as if the vermiculite contains asbestos unless testing proves otherwise. Encapsulation by an appropriately trained asbestos control professional is allowed. Removal is not allowed. Blower door testing should be done with pressurization rather than depressurization.

41200 Lead Safe Weatherization (LSW)

Each agency must give notification to the occupants of homes to be weatherized regarding the potential hazards of lead paint and lead paint dust if the home was built prior to 1978. The EPA publication "Renovate Right: Important Lead Hazard Information for Families, Child Care Providers and Schools" must be given to an adult occupant of the affected home. For occupied homes, the weatherization staff, crew, or contractor must have an adult tenant or homeowner sign an acknowledgement after receiving the pamphlet. The pamphlet can also be sent by certified mail with a receipt to be placed in the customer file.

Lead-Safe Weatherization (LSW) includes weatherization worker protection, general LSW work practice standards, and lead dust containment standards. Please refer to the latest weatherization program standard for details.

1. Level 1 Containment.
    a. Level 1 containment is required in pre-1978 homes when less than 6 ft^2 of interior painted surface per room or 20 ft^2 of exterior painted surface will be disturbed.
    b. Level 1 containment consists of methods that prevent dust generation and contains all debris generated during the work process. The containment establishes the work area that must be kept secure.
    c. The following measures may fall within this guideline:
        i. Installing or replacing a thermostat.
        ii. Drilling and patching test holes.
        iii. Replacing HEPA filters and cleaning HEPA vacuums.
        iv. Changing furnace filter.
        v. Removing caulk or window putty (interior).
        vi. Removing caulk or window putty (exterior).
        vii. Removing weatherstripping.
2. Level 2 Containment.

a. Level 2 containment is required when weatherization activities will disturb more than 6 ft^2 of interior surface per room or 20 ft^2 of exterior surfaces in homes built prior to 1978. Level 2 containment consists of methods that define a work area that will not allow any dust or debris from work area to spread. Level 2 containment requires the covering of all horizontal surfaces, constructing barrier walls, sealing doorways, covering HVAC registers with approved materials, and closing windows to prevent the spread of dust and debris.

b. The following measures may require level 2:
   i. Drilling holes in interior walls.
   ii. Drilling holes in exterior walls, removing painted siding.
   iii. Cutting attic access into ceiling or knee walls.
   iv. Planing a door in place.
   v. Replacing door jambs and thresholds.
   vi. Replacing windows or doors.
   vii. Furnace replacements.

c. Additionally, Level 2 containment must ALWAYS be used where any of the following is conducted (even if the activities will disturb less than the hazard levels within the Level 1 category):
   i. Window replacement.
   ii. Demolition of painted surface areas.
   iii. Using any of the following: Open-flame burning or torching; machines to remove paint through high-speed operation without HEPA exhaust control; or operating a heat gun at temperatures at or above 1100 F^O. Note that the use of a drill, reciprocating saw, or other power tool is considered a "machine" for removing paint. As examples: Cutting an attic hatch inside the dwelling or interior drilling of holes for the installation of insulation require level two containment.

3. There must be adequate documentation in the client file to demonstrate that lead-safe weatherization measures were performed when necessary. Documentation should include photos of the site and containment set up, as well as a listing of materials used and measures taken. The post-work inspector must also certify that LSW procedures were used and properly implemented.
4. New Mexico Weatherization will adhere to EPA lead safe rules as written in the "Lead; Renovation, Repair, and Painting Program" Final Rule (LRRPP Final Rule), as directed by DOE.
5. Weatherization of HUD program housing stock, including HUD Section 8, is infrequent in New Mexico. These units will only be weatherized if HUD will provide certification that abatement or control of any lead paint hazard has been addressed and will agree that the local agency will not be liable for any lead hazards, provided the safe work practices generally outlined above are employed.
6. In cases where the agency cannot safely weatherize a home due to lead paint hazards, the agency may defer the work. Such deferral will be considered by the state on a case-by-case basis. Agencies may not weatherize dwellings where cases of documented or suspected lead poisoning exist. Additionally, they shall not weatherize homes where there is an extraordinary lead paint hazard with no means to abate the hazard, including insufficient funds or insufficient training to properly address the hazard.

41300 *Moisture Remediation, Assessment, and Repair*

41310 Remediation of Mold

The use of DOE funds for the removal of mold and other related biological substances is not an allowable weatherization expense. Generally, DOE funds should not be used to test, abate, remediate, purchase insurance, or alleviate existing mold conditions identified during the audit/estimate, the work performance period, or the quality control inspection. Other funding sources should be sought to cover the cost of cleaning or cleaning moldy surfaces.

In New Mexico, excessive moisture might be a problem. Common approaches for dealing with potential moisture problems include the following measures:

1. Repair or installation of bathroom and kitchen exhaust fans.
2. Installation of ground moisture barriers of 6 mil black plastic under enclosed foundation mobile homes, houses receiving sidewall insulation, or any house with excessive dampness in the crawl space, including mobile homes.
3. Air sealing and duct sealing.
4. Removal of unvented space heaters.
5. Repair or installation of dryer vents to be properly vented to beyond the perimeter of the crawl space or basement.
6. Sealing attic bypasses to prevent air from carrying moisture into an attic.
7. Adding crawl space venting, but only when appropriate.
8. Replacement of downspouts and/or gutter sections to divert moisture away from the dwelling may be done with MFA approval. Please refer to Section 2600 on page 12 for information regarding allowable repairs.

41400 *Energy Related Mold and Moisture*

Moisture, mold, and mildew can seriously affect the health and safety of the client and crew. Steps must be taken to alleviate moisture problems. The New Mexico Weatherization Program shall ensure that regular weatherization work is performed in a manner that does not contribute to the increase of any mold problems and that properly performed work may alleviate many mold conditions.

The Weatherization Assistance Program is not a mold remediation program. The use of DOE funds for the removal of mold and other related biological substances is not an allowable weatherization expense. If necessary, Weatherization Program services may need to be deferred until the existing mold problem can be corrected or referred to another agency for funding of remedial action.

41410 Assessment of Moisture Conditions

All homes should be checked for previous or existing moisture problems.

1. A moisture assessment must be conducted with special attention to the following signs:
   a. Evidence of condensation on windows and walls indicated by stains or mold.
   b. Standing water, open sumps, open wells, dirt floors, water stains, etc. in basements or crawlspaces. Also, check to see if firewood is stored in the basement and whether laundry is hung to dry during the winter months.
   c. Leaking supply or waste pipes.
   d. Attic roof sheathing that shows signs of mold or mildew.
   e. Active roof leaks.
   f. Dryer fan and bath exhaust fan ducting that is nonexistent, damaged or constricted, too long, or not connected to outdoors.
   g. Presence of unvented space heaters.
2. Identification of existing or potential moisture problems shall be documented in the client file.
3. If existing moisture problems are found, no air sealing should be done unless the source of the moisture can be substantially reduced or mechanical ventilation can be added to cost-effectively remove the moisture. In some cases, air sealing must be done in order to reduce the source of the moisture (i.e., sealing off crawl spaces from the house, or sealing attic air leaks to eliminate condensation on the roof deck).
4. Because air tightening may cause an increase in relative humidity, client education should include information about moisture problems and possible solutions.
5. In the course of weatherization, any low-cost measures that help reduce the humidity levels in the house should be installed. Examples of these activities are venting dryers to the outdoors, venting existing bath or kitchen exhaust fans, or installing moisture barriers on dirt floors.

41411 Mitigation of Moisture, Mold or Mildew – Deferral of Service

If an existing moisture, mold or mildew problem is found, the agency must determine whether the moisture problem can be fixed under the scope of weatherization or if there should be a Deferral of Service because of the severity of the problem (typically 10 square feet or more of affected surface).

a. If it is determined that the problems are too severe under the scope of weatherization, a Deferral of Service form shall be signed at the time of inspection and left with the client and a copy placed in the client file.
b. Client education must be given to the client to inform them of the health and safety problems associated with mold or mildew and the possible self-help solutions they can perform at a later date.
c. The agency should try to refer the client to other programs or agencies that may be able to assist in resolution of the problem.

41412 Mitigation of Moisture, Mold or Mildew – Mitigation as Part of Weatherization

If an existing moisture, mold, or mildew problem is found and the agency determines that the job can be completed or cleaned under the scope of the Weatherization Program, then the following steps will be taken:

1. The agency will have the client sign the Homeowner Consent Form informing the client of the existing problem(s), leaving a copy with the client and a copy in the client file.
2. Because air tightening may cause an increase in relative humidity, client education should include information about potential adverse health effects and possible solutions when moisture problems are left untreated.
3. The agency will repair or eliminate the moisture problem and weatherize the dwelling in accordance with program regulations.
4. Containment of the work area is not necessary if the affected area is less than 10 square feet of surface area. Vacating people from spaces adjacent to the work area is not necessary, but is recommended when children less than 12-months old are in the house. People suffering from any health conditions should be kept away from the area being cleaned.

41413 Mitigation of Moisture Sources as Part of Weatherization

1. In the course of weatherization, measures that help reduce humidity levels in the house may be installed. Examples of these measures are venting dryers to the outside, venting existing bath or kitchen exhaust fans or installing moisture barriers on dirt floors. Repair of moisture problems that might 1) result in health problems for the client 2) damage the structure over the short- or long-term, or 3) diminish the effectiveness of the weatherization measures must be done before the weatherization job is completed.
2. Moisture problems can be reduced or eliminated by controlling the source of the moisture (most of these measures are subject to cost limitations). Moisture source control can involve the following measures:
   a. Installing a ground moisture cover on a crawlspace or basement floor.
   b. Venting dryers to the outside of the dwelling.
   c. Sealing the foundation.
   d. Providing positive drainage away from the foundation.
   e. Repairing the roof, flashing, gutter, and downspouts.
   f. Educating the client about the sources of moisture that they are able to control.
   g. Removal of unvented space heaters.
3. Moisture problems can be reduced or eliminated by ventilating areas where excessive moisture is produced such as bathrooms and kitchens. This measure should include installation of a high quality properly sized exhaust fan in the subject area and informing the client of the related moisture issues and the proper operation and use of the fan.

41414 Dryer Vents

1. Electric and gas dryers must always be vented to the outdoors.
   Dryer vent pipe should not be installed with sheet metal screws or other intrusive fasteners that will collect lint (according to NFPA 54).
2. Extend mobile home dryer vents through the skirting to the outdoors.
3. Dryer vent ductwork should be smooth-surfaced. No more than two 90º elbows may be used in the vent system, and the ductwork should not exceed 15 feet. If three 90º elbows are required, the total length of the vent may not exceed 10 feet. Alternately, the duct diameter can be upsized one or two inches.

41500 Ventilation Systems for Acceptable Indoor Air Quality

An ideal ventilation strategy provides spot exhaust ventilation where the moisture and other pollutants are created, and also provides dilution ventilation to the entire home to provide fresh air for the occupants.

ASRHAE 62.2-2010, *Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings*, shall be used for the installation of ventilation systems, both local ventilation and whole-building ventilation.

Existing operable fans that will remain in place and serve as part of the ventilation system shall be measured for CFM airflow. This airflow shall be recorded.

1. Bathroom ventilation
   a. Must have on-demand fans that exhaust at least 50 CFM and are controlled by an on/off switch or a time-delay-shutoff switch; or
   b. Must have continuously operating 20 CFM fan. A continuously operating bathroom fan or a programmed intermittently operating fan may serve as the whole-building ventilation.
   c. If a bathroom does not have this amount of ventilation stated in 1.a. or 1.b. above, it must be provided or Appendix A of ASHRAE 62.2-2010 must be used for sizing whole-building ventilation.
   d. Installed fans must have a back-draft damper at the fan, at the duct termination, or at both locations.
2. Kitchens ventilation
   a. Must have on-demand fans that exhaust at least 100 CFM and are controlled by an on/off switch. A vented range hood is required if the fan airflow is less than five kitchen ACH; or
   b. Must have continuously operating fan that exhaust at least five ACH based on kitchen volume. A continuously operating bathroom fan or a programmed intermittently operating fan may serve as the whole-building ventilation.
   c. If a kitchen does not have this amount of ventilation stated in 2.a. or 2.b. above, it must be provided or Appendix A of ASHRAE 62.2-2010 must be used for sizing whole-building ventilation.
   d. Installed fans must have a back-draft damper at the fan, at the duct termination, or at both locations.

e. Make-up air should be provided for kitchen fans exhausting more than 200 CFM.

3. Whole-building ventilation operating continuously shall be no less than 7.5 CFM per person + 1 CFM per 100 ft2 of conditioned floor area. If the number of people living in the dwelling is not known, or if the number of bedrooms plus one is greater than the number of people, the number of bedrooms plus one shall be used to determine the occupant number.
   a. This ventilation may operate intermittently; however, the following conditions must be met:
      i. The CFM airflow must be increased accordingly while the fan is operating. For example, a flow rate of 25 CFM for continuous operation would be increased to 50 CFM for 30 minutes-on-30-minutes-off operation.
      ii. The fan must operate at least once every four hours.
      iii. The fan must be controlled automatically.
      iv. The fan control must be appropriately labeled.
   b. If the bathroom and/or kitchen fans do not satisfy the requirement of 50 CFM and 100 CFM airflow rates, respectively, Appendix A (Alternative Compliance Supplement) must be used when sizing the minimum whole-building airflow rate.
   c. The whole-building ventilation may be a single exhaust fan, multiple exhaust fans controlled appropriately, or a balanced system such as a heat recovery ventilator. It may also be part of the furnace/central air-conditioning air handling system.
      i. Local bathroom and/or kitchen exhaust fans are permitted to be part of the whole-building ventilation system.
      ii. The system must be designed to operate during all hours of occupancy. A readily available override control must be provided to the occupant.
   d. Whole-building minimum ventilation requirements shall be determined with ZipTest Pro3 software for the TI-89 calculator, version 1.2 or later; ResVent 62.2 for the iPhone, version 1.1 or later; or by another method approved by New Mexico MFA for the agency.
      i. The infiltration credit shall be calculated as part of the procedure.
      ii. The alternative compliance supplement (Appendix A of ASHRAE 62.2-2010) shall be included when bathrooms or kitchens do not meet the local ventilation requirements.
   e. Whole-building ventilation discretionary threshold:
      i. If the whole-building minimum ventilation requirement is 15 CFM or less, the energy auditor may decide whether or not to install a whole-building ventilation system. The reasons for not installing a ventilation system when the minimum CFM requirement is between one and 15 shall be documented in the client file. This decision shall be based on the following factors:
         1. The moisture assessment of the dwelling,
         2. The indoor air quality assessment of the dwelling,
         3. The health of the occupants.
         4. Other factors deemed significant by the energy auditor.
      ii. If the whole building minimum ventilation requirement is greater than 15 CFM, a system supplying the design ventilation airflow must be installed unless a written waiver is granted by MFA.

f. Installed fans must have a back-draft damper at the fan, at the duct termination, or at both locations.

4. Fan sound ratings
   a. Fan sound ratings shall be equal to or less than the ratings in Table 4-1.

Table 4-1

Maximum Fan Sound Ratings		
New Replacement Fans	***Existing Retained Fans***	***Maximum Sound Rating***
Local bath, on-demand		3.0 sones or 50 dBA*
	Local bath, on-demand	N/A
Local bath, continuous		1.0 sone or 30 dBA*
	Local bath, continuous	N/A
Local kitchen, on-demand		3.0 sones or 50 dBA*
	Local kitchen, on-demand	N/A
Local kitchen, continuous		1.0 sone or 30 dBA*
	Local kitchen, continuous	N/A
Whole-building		1.0 sone or 30 dBA*
	Whole-building	1.0 sone or 30 dBA*
* A-weighted decibels measured at five feet from fan grille. Source: ASHRAE 62.2-2010.		

5. Ductwork
   a. Ducts outside of the thermal envelope shall be insulated to a minimum of R-63.
   b. Rigid ductwork with a smooth interior surface is recommended over flexible ductwork.
   c. Duct support
      i. Rigid ducts will be supported at intervals of four feet or less. Supports shall have a width of at least 1 ½ inches.
      ii. Flexible ducts will be supported at intervals of two feet or less. The maximum amount of support between supports shall be ½ inch per foot of horizontal run, or less. Supports shall have a width of at least 1 ½ inches.
   d. Duct diameter will be equal to or greater than the exhaust fan outlet.
   e. Duct runs shall be as short as possible and shall have not more than one elbow of a maximum of 90 degrees.
   f. Kitchen fan ductwork shall be rigid, smooth metal of at least 30-gauge wall thickness.
   g. Rigid ducts
      i. Metal-to-metal or metal-to-PVC connections shall be fastened with a minimum of at least three equally spaced screws.
      ii. PVC-to-PVC joints shall be joined with approved PVC cement.

[3] Based on *2009 New Mexico Energy Conservation Code*, Section 14.7.6.14.

iii. In addition to mechanical fasteners, seal duct connections with UL 181B or 181-M listed material. Exception: PVC connections.

iv. Rigid ductwork shall be sized according to Table 4-2.

h. Flexible ducts

i. Shall not be bent around framing members of other objects.

ii. Extend flex duct to its full length so that the excess length is no more than five percent.

iii. When flex duct is run through confined spaces, do not reduce the diameter of the flex duct in order to fit it within the space.

iv. Repair tears in flex duct vapor barrier using a recommended material.

v. Attach sections of flex duct according to the manufacturer's recommendations.

vi. Flex-to-metal or flex-to-PVC joints shall be fastened with tie bands using a tie band tensioning tool.

vii. Flexible ductwork shall be sized according to Table 4-2.

Table 4-2

Prescriptive Duct Sizing*								
Duct Type	**Flex Duct**				**Smooth, Rigid Duct**			
Fan Rating, CFM[+]	50	80	100	125	50	80	100	125
Duct Diameter, inches	**Maximum Length, feet**							
3	X	X	X	X	5	X	X	X
4	70	3	X	X	105	35	5	X
5	NL	70	35	20	NL	135	85	55

* This table assumes no elbows. Deduct 15 feet of allowable duct length for each elbow.

[+] Fan rating @ 0.25 inches of water column.

NL = no limit on duct length of this size.

X = not allowed, any length of duct of this size with assumed turns and fitting will exceed the rated pressure drop.

Source: ASHRAE 62.2-2010, Table 5.3, page 6.

i. Duct terminations, exhaust

i. The termination collar shall be at least the same equivalent size as the exhaust fan outlet.

ii. Termination fasteners shall not inhibit damper operation.

iii. Exterior termination will be flashed or weather sealed.

iv. Galvanized hardware cloth with no less than ¼-inch and not greater than ½-inch hole size will be used to exclude pests.

v. Terminations shall be at least three feet from any property line or any operable opening in houses and at least 10 feet from any mechanical inlet.

vi. Metal or other approved material shall be used for the termination fitting for kitchen exhaust.

vii. All existing mechanical exhaust ventilation systems should terminate outside the building shell by extending the ventilation duct through the roof or sidewall. Soffit terminations should not be used.

j. Exhaust grille location
   i. For local bathroom or kitchen exhaust, the grille shall be installed in the space where contaminants are generated.
   ii. For whole-building ventilation when other local bathroom and/or kitchen ventilation is present, the grille shall be located central location within the main body of the dwelling.
   iii. For whole-building ventilation when no local ventilation is present, the grille shall be installed in the central bathroom with the highest moisture generation.

k. Furnace air handle ductwork used as whole-building ventilation, supply ductwork from the outdoors to the return plenum
   i. System shall be installed according to the manufacturer's instructions.
   ii. Supply ducts shall be attached as close to the system as possible while remaining in compliance with manufacturer's specifications.
   iii. System shall be set up to provide filtration of air before reaching the air handler system. Intake filters shall be accessible for maintenance, shall not produce ozone, and the occupant shall be educated on how and when to change the filter.
   iv. A motorized damper will be installed between the intake fitting and the return side of the air handler. The damper control will be linked to the programmed operation controlling device. This damper will be accessible for maintenance.
   v. Intakes for supply air shall be located to the following specifications:
      1. Six feet above grade.
      2. At least 10 feet from exhaust outlets, plumbing vent outlets, or combustion vent outlets.
      3. Above local snow or flood line.
      4. Eighteen inches above an asphalt-based or flat roof.
   vi. Airflow CFM shall be measured during commissioning.

6. Attached garage exhaust fans
   a. Any ventilation in garages shall be exhaust only.
   b. Testing for leakage between the garage and the living area of the dwelling shall be conducted according to Section 13900 on page 130.
7. Instructions, labeling, and client education[4]
   a. A ventilation system operation guide designed for the occupants (non-professionals) to explain why the system was installed and how to operate and maintain the system shall be provided.
   b. This guide shall be reviewed with the occupants.
   c. Controls shall be labeled as to their function, unless that function is obvious (such as on-demand bathroom exhaust switches).
   d. Clients shall be asked to sign a document attesting to the fact that they have been informed about the installed ventilation system.
8. Commissioning
   a. Airflows of local bathroom and kitchen fans and whole-building fans shall be measured after installation to ensure that the design CFM airflow has been achieved.

[4] Please refer to ASHRAE Guideline 24-2008, Chapter 13, Operations and Maintenance Documentation, for guidance.

41600 *Combustion Safety Testing*

With the integration of blower door technology and dense pack sidewall insulation, houses are being sealed tighter than ever before. In accordance with the "house-as-a-system" approach to weatherization, we recognize that existing indoor air quality conditions may be intensified by air sealing techniques.

1. Therefore, the following health and safety measures must be performed on all combustion appliances of weatherized homes.
    a. Measurement of ambient carbon monoxide concentrations should be done. If any ambient level of CO above 9 ppm is found, the source must be identified and the problem corrected.
        i. The energy auditor should enter the dwelling with their CO measurement instrument running so that they can check the ambient CO concentration throughout the dwelling.
        ii. An ambient air test for CO should be taken on coal, wood, unvented heaters and gas cook stoves.
    b. A CO test of undiluted flue gases must be done on all vented combustion appliances. If a CO level above 100 ppm as-measured is found in the undiluted flue gas sample, corrective action must be taken to reduce the CO to acceptable levels. If readings are detected above the minimum levels, no weatherization work is to be done until the problem is corrected.
    c. A gas leak detection test must be taken on all natural and LP gas appliances and supply lines. All gas leaks must be repaired before any work is done. Oil supply lines and components must also be checked for leaks.
    d. Spillage and draft tests on all Category I natural gas, LP gas, and oil appliances must be performed under worst-case depressurization conditions to ensure an adequate venting.
    e. An inspection of the vent system must be completed to ensure that the proper size and type of pipe is used, the condition of the vent pipe is satisfactory, the clearance meets applicable codes, and the vent system is unobstructed.
    f. Identification and inspection of the combustion air source to make sure it is unobstructed and sufficient as defined by NFPA code.
2. A detailed description of these tests can be found in Section 13800 on page 123.
3. The local agency is responsible for any potential health and safety problems that will be compounded if prescribed conservation measures are installed. For example, if a furnace is emitting unacceptable levels of CO, it is likely that tightening the home would increase the problem. Therefore, this problem must be fixed before any air sealing is completed.

41700 *Carbon Monoxide Alarms*

1. At least one CO alarm must be installed in each weatherized dwelling. Follow the manufacturer's recommendations for locating and installing the alarm. Typically, alarms are installed where the clients spend most time, such as near bedrooms. If an entire multi-family building is to receive weatherization services, a CO alarm should be installed in each unit of the complex.
    a. Combustion appliances are defined as any piece of equipment (such as a water heater, cook stove, or heating system) that burns a fuel such as wood, kerosene, oil, natural gas, or propane.

b. Unvented space heaters are expressly prohibited in weatherized homes unless they are a secondary heat source.

2. All installed CO alarms must meet the following specifications:
   a. Be UL 2034 listed.
   b. Have an electrochemical sensor with a 5-year warranty.
   c. Be a plug-in type with a battery backup or battery operated units with a 5-year warranty.
   d. Have a sensor life monitor that alarms after five years or at the expiration of the useful sensor life.
   e. Have a digital LCD display.
   f. Sample ambient air at least every two minutes.
   g. Have an alarm of 85 decibels at 10 feet.
   h. Be capable of displaying the current CO level detected from 1 ppm to 500 ppm CO, the peak level detected, and the total time peak level was recorded.
3. Customer education is a vital part of protecting households from the dangers of CO. Ensure that client education regarding the potential hazards of combustion appliances is delivered.
4. The cost of the CO alarm or combination CO and smoke alarm is a health and safety material cost.

41800 Smoke Alarms

If smoke alarms are inoperable or non-existent, at least one alarm must be installed in each weatherized dwelling. If existing hard-wired smoke alarms are inoperable or broken, they must be replaced with comparable units.

41900 Electrical Safety

41910 Knob-and-Tube Wiring

1. Where live knob-and-tube wiring exists, the agency must mitigate all risks before weatherization measures can be taken. The following conditions must be met in order to install attic insulation:
   a. If funds are available, it is preferred to remove or deactivate live knob-and-tube wiring.
   b. If the wiring is not deactivated:
      i. Wiring insulation must be intact and complete with no exposed areas and connections.
      ii. S-type fuses that match the size of the wiring must be installed if they do not already exist. Any modification of the electrical panel must have prior written permission from the client. The agency must use a licensed electrician where questionable safety conditions exist.
      iii. When installing cellulose or fiberglass, there must be a minimum of 1-inch clearance from the knob-and-tube wiring. When cellulose is installed, precaution must be taken to prevent the possible drifting of the product, which could result in contact with the wiring.
2. The presence of knob-and-tube wiring, overloaded circuits, live bare wires, asbestos siding, or untreatable moisture in the wall cavities will be allowable reasons for not

insulating exterior walls. If the problems can be corrected within reasonable means, the walls may be insulated.

41920 Junction Boxes

All visible electrical connections must be inside approved electrical junction boxes. These junction boxes must have appropriate covers and must be flagged when concealed with insulation.

41930 Ground-Fault Circuit Interrupter Devices

1. Test ground-fault circuit interrupter (GFCI) devices to ensure that they are working properly in dwelling bathrooms and kitchens.
2. If a GFCI is not installed in a dwelling's bathroom, an agency may have one installed.

42000 Exceptions

1. Diagnostic equipment or test procedures should not be used in or on dwellings where such equipment or testing could exacerbate existing problems or pose a threat to the health of occupants.
2. In all cases, it is the auditor's responsibility to determine if a condition exists that could cause any diagnostic equipment or test procedure to be potentially harmful to clients or weatherization personnel.
3. If the potential exposure can be eliminated by varying the test procedure while still achieving reliable results, doing so is permissible and encouraged. For example, in a home with possible airborne pathogens, pressurizing as opposed to depressurizing during the blower door test should garner the necessary data safely. If no viable alternate test procedure exists, elimination of the test in question is allowable in the subject home. Other conditions where a blower door test might not be required include:

a. An open (non-airtight) solid fuel appliance is in operation at the time of the energy audit or inspection. In such cases, it is often possible to postpone the blower door test until the solid-fuel appliance is not combusting.

4. All required testing shall be done to the extent allowed by law.
5. For any required testing that is not done, the reasons for omitting the test must be documented in the client file. Photos of potentially hazardous conditions or materials should be included.

5000 Air Sealing Guidelines

Although no prescriptive list of treatments is applicable to every dwelling type, some treatments are typically cost-effective when applied to most dwellings. Air sealing is cost effective in the vast majority of dwellings; the difficulty is determining the amount of air sealing to do. In all cases, air sealing should be continued in a dwelling until it is no longer cost effective. The procedures below are intended to help the crew or contractors find the cost-effective level of air sealing.

It is important to remember that when air sealing, a air barrier or pressure boundary is being created. It is best if this pressure boundary has the following features:

1. Alignment with the thermal boundary (insulation).
2. Airtight and continuous.
3. Durable so that it will last as long as the insulation with which it is aligned.
4. Tested for tightness and thoroughness before insulation is installed.

   As an exception to this, dense-packed wall insulation serves as a good insulator (thermal boundary) and it also serves as an air barrier (actually a retarder). Unless there are holes in a wall large enough to allow loose insulation to escape, air sealing does not need to be done before the installation of the wall insulation.

Air leaks can be found in a number of ways including the following methods:

1. Use of an infrared camera before and then during the initial blower door test (when the temperature differences between the outdoors and indoors are large enough, the blower door should run for 10 to 15 minutes to allow the surfaces to cool/warm as a result).
2. Observing tracer smoke movement while a blower door is depressurizing/pressuring a dwelling.
3. Almost fully closing an interior door while a blower door is depressurizing/pressuring a dwelling and using your hand to feel for airflow through the small opening of the door.
4. Looking for dirt marks on existing fiberglass insulation. The fiberglass filters out the dirt which is what you see deposited on the fiberglass.
5. Spiders tend to build webs near airflow to catch insects. Where there are webs, there is usually air leakage.
6. Watching spider webs or other objects move in the airflow created by a blower door.
7. Listening for airflow (whistles) during a blower door test.

Air sealing shall begin with gross air sealing and then move to blower door guided air sealing. It is preferred to have a blower door set up so that the effectiveness of air sealing can be measured as the crew or contractor progresses through the process.

5100 Gross Air Sealing

Gross air sealing includes obvious large holes, missing envelope components like window glass or door panels, or doors or windows that are stuck open. Eliminating these air leaks is obviously cost effective. The initial blower door test should be done before gross air sealing.

1. Seal all large openings in the envelope (e.g., holes in the walls, floors, or ceilings, missing sheetrock, missing or broken glass, missing windows, etc.).
2. Continue with blower door guided air sealing.

5200 *Blower Door Guided Air Sealing*

As the name suggests, blower door guided air sealing utilizes a blower door during air sealing activities to guide the process. Operate the blower door in depressurization mode while inspecting for leaks. Do not forget to check for leaks in a conditioned basement. If inspecting for leakage in an attic, it is best to pressurize the dwelling with the blower door by reversing the blower door fan. This type of air sealing work is usually cost-effective only up to a point. Once that point is reached, air sealing work should cease. Stop air sealing when the higher of the following CFM50 values is reached:

1. The Air Sealing Target (AST) CFM50 value is reached (refer to Section 13200 on page 115). The lowest AST shall be 1000 CFM50.
2. The Depressurization Tightness Limit (DTL) CFM50 value is reached. Refer to Section 13300 on page 116.

Air leaks are to be sealed from the largest openings first and progressively working to the smaller leaks.

1. Due to the stack effect, the most critical leaks are often those in the top part and lowest parts of the house. Always check:
   a. Chase ways around chimneys.
   b. Plumbing and wiring penetrations.
   c. Interior wall cavities.
   d. Dropped ceilings.
   e. Junctures between floors.
   f. Electrical service entry.
   g. Rim joist leaks.
   h. Basement wall leaks.
   i. Knee wall bypasses
2. Ensure all attic sealing is complete. Often the best method for detecting air leaks between the living space and the attic is by reversing the blower door fan to pressurize the house while the attic floor is inspected. **NOTE: Always seal the attic properly before installing attic insulation.**
3. In mobile homes seal the plumbing chase behind washer and dryer, water heater closet, under/behind bath tub, and around the electric panel box.
4. Seal all duct leaks, both supply and return lines if the ducts are located in unconditioned spaces such as attics or crawl spaces.
5. Seal or install dampers in other openings such as dryer vents, kitchen and bathroom exhaust fans, window air conditioners, unused fireplaces and flues, etc.
6. Install dense pack sidewall insulation in all walls separating conditioned living space from exterior or unheated spaces, using the methods described in these Standards. A blower door test should be done to assess the status of the air sealing work.
7. Openings in recessed light fixtures must not be sealed unless the fixture is rated as a “Type IC” (zero clearance) fixture. However, non-Type IC recessed light fixtures may be boxed with a non-combustible enclosure in the attic. The interior sides of the box must be at least three inches away from any part of the recessed fixture. Insulation may be in contact with the exterior sides of this box, but the top of the box enclosure may not be insulated.

a. Non-IC type recessed fixtures may be replaced with IC type if it is deemed cost effective.

8. If additional air sealing is needed, move on to these areas that are generally less effective. Such measures can include:
   a. Tightening windows by weatherstripping or installing window channels. Re-glaze windows if there is noticeable air leakage, or if the window will likely deteriorate without re-glazing.
   b. Sealing doors with weatherstripping, sweeps, and thresholds. Make doors operate properly and replacement of entry locks as necessary.
   c. Caulking on the interior at baseboard, window, and door trim. This should only be done after walls are dense packed with cellulose and the operation of the blower door with tracer smoke indicates these areas are leaking.

5210 Air Sealing and Damming Around Chimneys and Vents

Special requirements are necessary for air sealing around chimneys and vents because of fire hazard. Follow the requirements below for such sealing.

1. Fire stopping around masonry chimneys "shall be of galvanized steel not less than 26 gauge thick or of noncombustible sheet material not more than ½-inch thick."[5] Such material must be used to seal gaps or chases greater than ¼ inch wide around masonry or metal chimneys. Aluminum flashing may not be used for this purpose. This fire-rated material must be sealed to the chimney and the surrounding framing and finish materials with high temperature caulking. Gaps of ¼ inch or less are to be sealed with high temperature caulking only. This treatment is intended to stop the flow of air and water vapor into the attic from these gaps or chases.
2. In addition to stopping the flow or air around a chimney, a block must be installed to keep insulation at least two inches from the masonry or metal chimney. This is to be accomplished with a block of a rigid material. If this material is not fire-rated, it must be at least two inches from the masonry or metal chimney. If an existing chimney or flue is treated incorrectly, correct it to comply with these standards. If it is not reasonable to bring a chimney up to these standards, document this fact in the client file and include photographs.

5300 Room-to-Room Duct-Induced Pressures

Room-to-room pressure(s) should be measured in all rooms with forced air heating return or supply ducts and operable doors with the air handler operating after all weatherization installations have been completed, but before post-weatherization combustion safety testing is performed.

When the dwelling is closed up in blower-door-test condition and the air handler is operating, the pressure difference across a closed interior door must be three Pascals or less. If the pressure difference is greater than three Pascals, the crew or contractor must lower the pressure to meet this requirement. Keeping these pressure differences below three Pascals reduces the dwelling air leakage when the air handler blower is running and interior doors are closed.

[5] NFPA 211 *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances*, 2006 ed., 7.1.6.3.

For instructions regarding this test, please see Section 13430 on page 119.

5400 Zone Pressure Diagnostics

Zone Pressure Diagnostics (ZPD) testing is highly recommended in some dwellings. ZPD testing is helpful in the determination of the location pressure boundaries and the effectiveness of air sealing measures. For example, ZPD is very useful before and after air sealing attic bypasses to determine the effectiveness of air sealing. Additionally, the air tightness of a common wall between a house and an attached garage can be measured with ZPD, both before and after air sealing.

Please refer to Section 13900 on page 130 for ZPD testing procedures.

5500 Duct Leakage

Duct leaks can lead to many problems in a dwelling, the most common one being wasted energy. Other problems can include thermal discomfort, substandard indoor air quality, and hazardous combustion venting.

Duct leaks can be 1) within the confines of the thermal boundaries of the building or 2) outside of the thermal boundaries, perhaps leaking to the outdoors. Mobile home ducts and site-built homes with ductwork in crawl spaces or attics are susceptible to leakage to and from the outdoors.

Although duct leakage within the thermal/pressure enclosure usually does not have a significant energy impact, it might impose a hazard to occupant health by causing poor indoor air quality or backdrafting of combustion appliances. These potential problems are addressed by performing the appropriate combustion safety testing.

Pressure pan testing must be performed in mobile homes and manufactured double-wide dwellings to determine if the ducts are leaking to a significant degree to or from the outdoors. Additionally, pressure pan testing must be performed in site-built homes that have ductwork in spaces outside of the thermal/pressure enclosure. Please refer to Section 8670 on page 91, Ducted Distribution Requirements, for more information. Also refer to Section 13700 on page 122 for duct leakage testing procedures.

6000 Insulation Requirements

6100 *Insulation Guidelines*

Adding insulation to the building shell is often the most cost-effective measure performed in the Weatherization Program. Insulation reduces heat loss through the building shell. Combined with the home's air barrier, insulation forms the thermal boundary. The air barrier and insulation thermal boundary should always be aligned with each other. Insulation should be installed without voids or gaps and should be protected from moisture. The R-values of common insulation materials are listed below in Table 6-1.

Table 6-1

R-Values Per Inch For Common Insulating Materials	
Insulating Material	**Avg. R-Value Per Inch**
Mineral wool	3.2
Fiberglass batt	3.2
Vermiculite	2.1
Perlite	2.7
Cellulose*, open-blow in attic	3.7
Cellulose*, dense-packed	3.4
Fiberglass (loose fill)	2.2
Rock Wool (loose fill)	2.2
Expanded polystyrene board (cut-cell surface)	4.0
Extruded polystyrene board (smooth cell surface)	5.0
Poly isocyanurate board, foil faced	6.0
Two-component polyurethane foam	6.0
* For the New Mexico weatherization program, cellulose insulation must be the borate-only grade.	

6200 *Attic and Roof Insulation*

Attic insulation in older homes is often both insufficient and ineffective due to poor installation, settling, subsequent work related activity, or unaddressed thermal bypasses. Attic insulation produces the best energy savings of any typical weatherization measure and often is the most cost-effective measure in terms of savings-to-investment ratio.

6210 Inspection, Preparation, and Repairs

1. Prior to installing insulation, a thorough inspection of the attic area must be performed by the energy auditor and then by the installers.
   a. The inspection must include a determination of the R-value and integrity of existing insulation, the location of air leaks from the conditioned spaces to the attic, and the suitability of the structure for receiving insulation.

b. The inspection should determine the necessity of any repair work associated with the installation of the attic insulation. Repairs should be completed before installing insulation. An additional description of allowable and necessary repairs is noted below. When extensive roof repair or a replacement is required, other funding must be solicited to offset the cost.
c. Attics should be tested for air leakage between the ceiling and attic space either by pressurizing the house with the blower door or using zone pressure testing. These tests should be conducted prior to, and then after, performing air sealing and installing insulation in order to determine the quality and completeness of the air leakage and bypass sealing. Attic sealing needs to be performed before insulation installation.

6220 Determining the Effective R-value of Existing Fiberglass Insulation

Voids in installed insulation must be accounted for when determining the existing R-value.

1. For existing insulation other than fiberglass:
   a. Measure the average thickness of the insulation. Multiply the R-value per inch from Table 9.1 by the average insulation thickness.
   b. Measure the area covered by insulation (the calculated value from the previous step) and the area and R-value of the voids. Use a weighted average calculation to find the effective R-value of the existing insulation/voids.
2. To find the effective R-value for fiberglass batt insulation, use the following procedure:
   a. Measure the average insulation thickness.
   b. Determine the condition of the installed insulation using the following ratings:
      i. Good - No gaps or other imperfections.
      ii. Fair - Gaps over 2.5 percent of the coverage area. This is the equivalent of a 3/8-inch space on one side of a 14.5-inch wide batt.
      iii. Poor - Gaps over five percent of the coverage area. This is the equivalent of a ¾-inch space on one side of a 14.5-inch wide batt.
   c. Look up the effective R-value using the table below:

Table 6-2

Effective R-Values for Fiberglass Batts			
Measured Batt Thickness, inches	"Good" Effective R-value of 2.5 per inch	"Fair" Effective R-value of 1.8per inch	"Poor" Effective R-value of 0.7 per inch
0	0	0	0
1	3	2	1
2	5	4	1.5
3	8	5	2
4	10	7	3
5	13	9	3.5
6	15	11	4
7	18	13	5
8	20	14	5.5
9	23	16	6
10	25	18	7
11	28	20	8
12	30	22	8.5
Based on *Heat Transmission Coefficients for Walls, Roofs, Ceilings, and Floors* by Timothy James and William Goss, ASHRAE, 1993.			

6230 Attic Air Leakage

1. All bypasses, such as plumbing and electrical chase ways and balloon wall cavities, must be thoroughly sealed before insulating.
2. Ensure that air leakage (attic bypasses) have been sealed before attic insulation is installed. Use zone pressure testing, infrared equipment, or tracer smoke in combination with a blower door to verify air leakage has been adequately treated.
3. When appropriate, replace non-IC type recessed lights with IC type before any new insulation is installed. New lighting must comply with local and state codes. The newly installed insulation may be in contact with the IC type recessed fixtures.

6240 Moisture Inspection and Repair

1. Roof leaks and all other attic moisture problems shall be repaired prior to the installation of attic or roof insulation.

2. All mechanical vents from exhausting and combustion appliances must be vented through the roof or sidewall. No exhaust fan vents, combustion appliance vents, or plumbing stacks may terminate in the attic.
3. Repair any moisture problems that will degrade or diminish the effectiveness of weatherization measures.

6250 Attic Access

1. There must be access to the attic provided for post work inspection and potential future needs of the client.
2. A gable vent on a hinged plywood or OSB door is considered adequate access.
3. An adequately sized gable vent held in place with screws (no nails) is acceptable if building a hinged door is impractical.
4. When it is necessary to install an interior attic access in the ceiling, it must meet the following specifications:
   a. At least 16 inches by 20 inches and a maximum of 18 inches by 24 inches.
   b. Weatherstripped and insulated to the same level as the attic floor, or with at least four inches of extruded polystyrene (R-20).
5. In pre-1978 homes, installation of an attic access must be performed using lead-safe work practices, and all dust and debris caused by the installation shall be wet-cleaned if lead has been found.
6. An attic ceiling access shall have an insulation dam on the attic side, made of rigid materials, that exceeds the height of the insulation to be installed. The dam must be strong enough to hold the weight of a person entering or exiting the attic. The use of fiberglass or other non-rigid material as a dam around the attic access is not allowed unless limited roof height restricts rigid material. In such a case, thick fiberglass batts are allowable.
   a. Approved attic access insulation dam materials include the following:
      i. Plywood of at least ¾ inch thickness.
      ii. Wood board of at least ¾ inch thickness.
      iii. Plywood of at least ½ inch thickness with ¾ inch by 2-½ inch strapping securely fastened to the exterior face of the plywood box, with the edge of the strapping flush with the top edge of the fabricated plywood box.
7. If there are no interior accesses, at least one exterior access to each attic space shall be left for inspection purposes. When it is necessary to install an interior access in a knee wall, it must be at least the width of the knee wall stud cavity and 24 inches high, and it shall be weatherstripped and insulated to the same R-value as the knee wall. At least one latch shall also be installed to ensure air tightness. If it is unreasonable to provide permanent access to all knee wall areas, the attic and/or knee wall area must be inspected by a post-work inspector before the area is sealed off. The insulation in the sealed knee wall area must be adequately documented in the client file with photo documentation.
8. If the attic access has pull-down stairs, a zipper insulating tent or prefabricated rigid insulation box is allowed.

6260 Attic Access Insulation

Any interior access hatch to the attic shall be weatherstripped and insulated with at least four inches of extruded polystyrene (R-20) that is properly secured to the exterior surface of the attic hatch. Refer to section 6250 on page 50.

6270 Insulation Shielding and Blocking

1. All electrical fixtures shall be blocked with rigid material to ensure a minimum insulation clearance of three inches and a maximum clearance of six inches. (*Exceptions to this rule include Type IC (insulation contact) recessed lights, Type IC light/fan combinations and closed junction boxes*.)
2. No insulation, including fire-rated insulation, shall be installed above recessed light fixtures so as to trap heat or prevent free air circulation. However, insulation may be installed over Type IC (insulation contact) light fixtures.
3. Blocking must be installed so that it is effective in shielding the heat source from the insulation, and no insulation shall be left within the blocked area.
4. Metal blocking must be notched so that it does not contact electrical wiring.
5. Fire stopping around masonry chimneys "shall be of galvanized steel not less than 26 gauge thick or of noncombustible sheet material not more than ½-inch thick."[6] Such material must be used to seal gaps or chases greater than ¼ inch wide around masonry or metal chimneys. Aluminum flashing may not be used for this purpose. This fire-rated material must be sealed to the chimney and the surrounding framing and finish materials with high temperature caulking. Gaps of ¼ inch or less are to be sealed with high-temperature caulking only. This treatment is intended to stop the flow of air and water vapor into the attic from these gaps or chases.
   a. In addition to stopping the flow or air around a chimney, a block must be installed to keep insulation away from the masonry or metal chimney. This is to be done with a block of rigid material. If this material is not fire-rated, it must be at least two inches from the masonry or metal chimney.
   b. If an existing chimney or flue is treated incorrectly, correct it to comply with these standards. If it is not reasonable to bring a chimney up to these standards, document this fact in the client file and include photographs.

6280 Treatment of Other Hazards

1. Use appropriate personal protective equipment and work practices in the presence of animal or insect hazards. Ensure personal safety during work.
2. Repair any rotted, broken, or damaged attic structural components. Ensure that the ceiling will safely hold the weight of weatherization workers and the insulation. Repair or replace any weakened, damaged, or missing interior ceiling surface.

[6] NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances*.

6290 Installation Methods for Attic Insulation

1. Locate and seal attic thermal bypasses, chases, and partition walls open to the attic. Remove enough of any existing flooring so that a thorough inspection for, and repair of, attic bypasses is possible. Properly treat ceiling height changes and stairwells as necessary to stop air leakage. Seal knee wall floor cavities. Make sure bypasses are completely sealed before installing any insulation.
2. Attic insulation must completely cover heated/cooled areas and must be installed at an even depth, except where physical constraints exist.
3. Insulation must be installed to the outside edge of the top plate of an exterior wall.
4. Insulation may not cover soffits vents or fill the eave/soffit area. Added insulation shall not restrict the airflow through vents. Rigid baffles of cardboard, rigid foam, or other appropriate material should be used at the soffit area to ensure venting and prevent loose insulation from entering the soffit area.
5. Insulation must be installed according to the manufacturer's specifications for coverage and R-value.
6. If the installation of cellulose insulation on top of existing batt or blanket insulation is warranted, cut or pull back existing fiberglass batts one-to-two feet from the soffit and blow the perimeter.
7. Cellulose is the preferred insulation to be installed in the attics of site-built homes.

62100 Insulation Coverage and Density

1. Insulate uninsulated open-joist attics to at least R-38 in climate zones three and four, to at least R-49 in climate zone five, and to at least R-60 in climate zones six and seven; unless a NEAT audit calculation for the dwelling supports a different cost-effective level of insulation[7].
2. If existing insulation is in place, use NEAT/MHEA to determine if it is cost effective to add insulation and, if so, the cost-effective amount to add.
   a. Insulation installers shall install at least two depth gauges located in a manner that will demonstrate the depth throughout.
   b. A verification label is to be posted by the installer near the attic access in each dwelling unit. This label shall include the following information:
      i. Installer's business name.
      ii. Date of installation.
      iii. Insulation type.
      iv. Settled insulation depth.
3. Insulate enclosed areas (under floors and behind slopes and knee wall cavities, etc.) to the following density levels as long as interior finish materials are able to withstand the pressure without damage:
   a. Blown cellulose at a density of 3.5 to 4.5 lb/ft^3.
4. Insulate knee wall cavities as follows:
   a. Blown cellulose at a density of 3.5 to 4.5 lb/ft^3.

[7] Please refer to *2099 New Mexico Energy Conservation Code* to find climate zone designations.

b. Blown fiberglass at a density of 1.6 lb/ft^3.
c. Fiberglass batt insulation.
d. Rigid foam board insulation.
e. 2-part foam insulation.

5. Where feasible, densely packing cellulose insulation with an appropriate hose or tube might help seal air leaks and bypasses in attics. However, dense packing cellulose in an attic does not eliminate the need to remove enough attic flooring in order to find and seal leaks with caulking, foam, and other materials before cellulose in installed.
6. Calculating the number of bags, as per manufacturer's specifications from product supplied, is the preferred method for determining the proper amount and density of material to be installed into an attic area at a given R-value.
7. When cost effective, it is preferred that airtight floors be built over the soffit drop to make it a part of the attic deck before attic insulation is installed.
8. Add insulation as necessary to eliminate voids and areas of incomplete coverage.

62110 Vaulted or Sloped Ceiling/Roof Cavities

1. Vaulted ceiling or sloped ceiling/roof cavities shall be insulated to a value of at least R-19 whenever possible. If it is not possible to insulate to R-19, the reason must be documented in the client file.
2. Any flammable insulation or flammable insulation coverings must be protected with a 15-minute fire-rated material, such as ½ inch drywall mudded once, or ¾ inch of wood. If blown insulation is used, it shall be dense-packed in the vaulted or sloped ceiling/roof cavities.

62120 Knee Wall Areas

1. Knee walls shall be insulated in a manner similar to exterior walls when they separate conditioned from unconditioned spaces.
2. Whenever possible, knee walls should be insulated with dense pack cellulose insulation.
3. They may also be insulated with fiberglass batts with a vapor barrier/retarder on all sides, rigid foam board insulation, or 2-part foam insulation. Consider the most cost-effective method for each situation.

62130 Enclosed Ceiling/Floor Cavities

When insulating enclosed ceiling cavities, it is preferred that insulation be installed in the rafter cavities from the attic, through the eave or from the interior of the home, rather than through the roofing materials.

62140 Storage Space

1. Where attic space is being used for storage before the attic is weatherized, agencies should request the client remove storage items from the area before the crew begins the job.
2. In cases where the client is physically unable to perform this task and is unable to solicit help from a family member or friend, agencies and contractors should include the removal of items in the cost-effective analysis of installing insulation, and proceed with the measure if it is cost-effective (if the job has an overall savings-to-investment ratio of 1.00 or greater).

62150 Attic Ductwork Insulation

1. Ductwork in attics must be sealed appropriately with the proper materials (duct mastic) before insulation is installed. Refer to Section 8600 on page 87 for instructions.
2. When working ducts are located outside of the thermal enclosure, install a minimum of R-8 on ducts and plenums.
3. A minimum of six inches of clearance between duct insulation and heat sources must be maintained, unless the insulation material is rated for closer proximity.
4. If ductwork outside of the thermal enclosure serves a cooling system, the duct insulation must have a vinyl or foil vapor barrier installed on the outer surface of the insulation unless two-part foam is used to prevent condensation on the ductwork.

62160 Floored Attic Insulation

If a drill-and-blow method is used for insulation in a floored attic, holes must be properly plugged, secured with adhesives, and sealed. Floor planks can also be removed to allow for access to blow cavities, and then reinstalled.

62170 Attic Venting

Attic venting should be installed when needed, but no attic should be over-ventilated because it can increase air leakage caused by the stack-effect. The primary means of moisture control in attics should be sealing attic bypasses, controlling indoor humidity levels, properly sealing attic bypasses, and insuring exhaust fans are extended to the outside.

62171 General Installation

1. Ensure that existing vents are not blocked, crushed, or otherwise obstructed. Correct problems as necessary, or replace.
2. When attic insulation is installed, a reasonable amount of attic venting should be in place unless local codes supersede.
3. All venting openings should have suitable louvers and screens to prevent snow, rain, and insects from entering the attic.

62172 High-Low Vents

1. Attic venting is most effective when there are equal amounts of low intake vents through soffits and eaves and higher exhaust vents on the roof.
2. Roof vents should be installed close to the peak.
3. Install high gable end vents at least three feet above the soffit or a gable vent used for low venting.

62173 Gable Vents

1. Gable-end vents should be installed as high in the gable as possible and positioned to provide cross venting.
2. Precautions shall be taken to block wind from “washing” insulation near the attic vents.

62174 Roof Vents

1. When roof vents are installed on the flat roof surface, they should be nailed and well sealed to the roof to prevent water leakage. If possible, roof vents should be located on the areas of the roof least visible from the ground.
2. If possible, roof vents should not be installed on a roof that is in poor condition.
3. Roof vents are not to be installed over rafters.
4. Roof vents should be tucked under shingles as much as possible. Surface mounted roof vents are not allowed.

62175 Knee Wall Venting

Knee walls or attic spaces that are sealed from other attic spaces may need to be ventilated as if they are separate attics.

62176 Attic Vent Area Guideline

When attic venting is installed, use the following guideline:

1. If the attic floor and bypasses are air-sealed and exhaust vent terminations extended to the outside, then one square foot of net-free venting should be installed for every 300 square feet of insulated attic floor area.

6300 Sidewall Insulation

Installing dense pack sidewall insulation with uniform coverage and density is a proven energy-efficiency measure because it maximizes the insulating value, minimizes insulation settling, and effectively reduces air leakage though the walls. Dense pack sidewall insulation must be completed where uninsulated wall sections exist, including walls that separate conditioned spaces from unconditioned spaces, such as garages or unheated porches. There must be

complete documentation in the client file giving adequate rationale whenever walls are not insulated.

6310 Moisture Inspection and Repair

Any leaks or other moisture problems must be repaired prior to the installation of wall insulation. Make reasonable repairs to walls. Use lead-safe work practices in all pre-1978 dwellings.

6320 Interior Inspection and Repairs

1. Make reasonable repairs to interior walls as needed. In pre-1978 homes, repairs to these surfaces can generate a lot of lead paint dust and debris, so lead-safe work and clean-up practices must be employed. Locate any areas of the interior wall surface that are weak or not securely fastened. Holes drilled for insulation must be plugged, finished, and returned to a condition as close to the original as possible.
2. Locate the positions of all wall-mounted switches and outlets before beginning insulation work. Locate all chases, utility runs, duct runs, wall heaters, vent fan penetrations, etc. prior to insulating. Insulation should not be installed against chimneys and some electrical fixtures. Block around these areas before installing insulation. If it is not possible to block around an area, avoid that area when insulating. Make sure all appropriate code clearance requirements are considered.
3. Find any interior soffit areas, pocket doors, or other structural details that may need preparation prior to insulating, and prepare as necessary. Locate critical framing junctures and ensure adequate insulation densities in these areas.

6330 Exterior Inspection and Repairs

1. Note all types of siding material. Note siding material that may contain asbestos and/or lead-based paint. If the home is pre-1978, lead safe weatherization practices must be followed.
2. Determine the best drilling strategy. The preferred method is to lift the siding or temporarily remove it before drilling the sheathing.
3. Repair or replace severely deteriorated window or door components as directed by the estimate. Replace all missing glass.
4. Patch holes in exterior walls.
5. Determine the source of, and correct any problem that has led to, moisture in wall cavities prior to installing insulation. Repair or replace damaged, rotted, or deteriorated siding to ensure the integrity of the insulation. If any missing siding, flashing, etc. would allow disintegration of installed insulation, replace it with a comparable material.
6. Access structural additions and critical junctures to determine the ability of these areas to contain high-density insulation. Correct any openings or gaps prior to installing insulation.

6340 Accessing Wall Cavities

Generally wall cavities on site-built homes are accessed from the outdoors by removing the siding with care, drilling the sheathing with an appropriate drill and bit, and then inserting the proper tube to dense pack the wall cavities with cellulose. Of course, some siding is more difficult to remove or access than others. It is always a good idea to start with the removal in a spot that is not very noticeable, say the back of the house behind some shrubbery. If you make a mistake it will not be as noticeable.

Here are some simple guidelines for removing and replacing different types of siding:

1. Wood clapboard siding should be carefully removed and replaced. This can usually be accomplished without damaging the siding. The sheathing should be properly plugged with wood or plastic plugs or foam insulation before the clapboards are re-installed.
2. Wood shingles or shakes must be cut with a knife at overlap and broken off. After the wall is insulated and the holes are properly plugged, the removed shingle or shake must reinstalled in the same place and be faced nailed after the sheathing hole is properly plugged.
3. Board-and-batten or tongue-and-groove wood siding cannot be removed. Because of this they must be face drilled.
    a. The homeowner must give written permission before this may be done. Horizontal rails can be placed over the file holes on the exterior walls as long as they are properly waterproofed.
    b. Rather than face drill, the homeowner can be offered the option of having insulation installed from the interior walls. This is messy and will require some interior work to cover the fill holes, but it is usually preferable to installation from the exterior wall. Chair rails can help conceal fill holes at waist height and wallpaper strips can conceal holes in the wall up near the ceiling.
4. Vinyl siding must be carefully unlinked with the lower piece of vinyl with a zip tool and then braced upward enough with spacers to allow the drilling of the sheathing. After the insulation is installed and the holes are properly plugged, the braces are removed and the vinyl is zipped back into place with the zip tool. Take extra care when removing and replacing vinyl in cold weather.
5. Steel or aluminum siding usually has the same profile (shape) as vinyl, however it is much more difficult to remove and replace without damage. Some skilled siding experts are able to remove aluminum and replace it without trouble, but this is an unusual skill. Many weatherization programs cut the siding just under the overhanging part with an oscillating cutter that makes a very narrow kerf (Fein MultiMaster tool is a popular manufacturer and brand). After the wall is insulated and the fill hole is properly plugged, the cut aluminum siding is face nailed and the remaining kerf is caulked as inconspicuously as possible.
6. Asbestos siding is very brittle because it is a cement product. It is also hazardous because it contains asbestos fibers. Because of this is should never be drilled, cut, or sanded. Workers should always take precautions to wear appropriate respirators. To remove the siding, the heads of the nails are cut and/or removed with a nipper taking care not to damage the siding. The siding is replaced by re-nailing it through the same nail holes.
7. Stucco, another cement product is very difficult to drill.
    a. Insulation can be installed from the outdoors by drilling the stucco with a carbide- or diamond-tipped bit. If holes are drilled in the stucco, the holes must

be patched so that the patch matches the color and texture of the existing stucco. This can be a challenge.

b. Insulation can be installed from the outdoors by cutting small squares in it with a circular saw and masonry blade. The cutout stucco squares must be replaced in same place from which they were cut. Once the squares are cut, the sheathing below is drilled for the cellulose tube. After the cavities are dense-packed with cellulose, the square cutouts are glued in place with panel adhesive. The kerfs around each square must then be caulked with a material that matches the stucco color and texture.

c. Rather than face drilling from the outdoors, the homeowner can be offered the option of installing the insulation from the interior walls. This is messy and will require some interior work to cover the fill holes, but it can be preferable to installation from the exterior wall. Chair rails can help conceal fill holes at waist height and wallpaper strips can conceal holes in the wall up near the ceiling. Agencies should offer their own solutions for locally appropriate interior cosmetics within the scope of the program.

8. Brick veneer is best to insulate from the inside. Cellulose should never be installed so that it is in contact with brick or stone that is exposed to the outdoors (precipitation); there must be a moisture-proof barrier between the brick or stone and the cellulose.

6350 Installation Methods for Wall Insulation

1. Wall areas above windows and doors (except in mobile homes), and the area below windows must be insulated, whenever possible.
2. Uninsulated exterior walls without drywall, paneling, or other interior finish material must be insulated if adding interior finish material and insulation is deemed cost-effective. If drywall is used to cover the insulation, it must be taped and mudded with one coat. (*If faced fiberglass batt insulation is used, it must not be left exposed in habitable areas.*)
3. For all enclosed walls, insulation must be installed using the tubing method rather than the nozzle method. (*As an exception, a nozzle may be used in small cavities such as above windows and doors.*)
4. Walls must be dense-packed whenever the interior wall surface material allows. Dense-packing requires:
   a. An insulation machine with the proper capacity (at least 80 inches of water pressure at takeoff or 2.9 pounds per square inch of pressure).
   b. The proper machine settings. For dense-packing, the air-to-material ratio must be high enough for a cellulose density of at least 3.5 pounds per cubic foot. On the other hand, if this ratio is too high, the job of insulating will take much longer. A balance must be found for each machine, delivery system, and wall.
   c. Effective delivery of the insulation material from the machine to the end of the wall tube requires the following equipment specifications:
      i. No air leaks in the hose or at the joints.
      ii. A hose that is as short as possible for the job, but at least 50 feet.
      iii. Gradual reductions or transitions in the delivery system to minimize clogging.
      iv. A tube that is cut at an angle at the end to facilitate insertion into the wall cavity.

d. An effective technique is as follows:
   i. Inserting the tube all the way up to the top plate and then pulling down just less than one foot before the machine is turned on.
   ii. Pulling the tube out of the fill hole by just less than one foot at a time as the flow in the hose and tube slows and stops due to increasing resistance in the cavity. If the tube is pulled out too soon, the density will decrease.
   iii. Inserting the tube downward through the fill hole after the wall cavity is filled upward from the fill hole. Inserting the tube with only the air running will help "drill" through the cellulose that has fallen from the upward fill. This will help achieve a higher density in the downward fill.

6360 Blocking

Construction details that allow insulation to escape from sidewall cavities such as balloon-framed walls must be blocked or packed with insulation or other material in a manner that effectively retains the insulation material.

6370 Insulation Coverage, Density, and Voids

1. Sidewall insulation must be installed according to the manufacturer's recommended density, and in a manner that does not allow the material to settle.
2. When insulating sidewalls with cellulose in site-built dwellings, install the insulation to a density of 3.5 – 4.5 lbs/ft^3 using the tubing method, unless there is good reason not to dense-pack. If the insulation is not installed to at least 3.5 lbs/ft^3, documented reasons must be included in the client file. Cellulose is the preferred insulation for dense packing walls.
3. When insulating sidewalls with blown fiberglass in site-built dwellings, install the insulation to a density of 1.6 lbs/ft^3 using the tubing method, unless there is good reason not to dense-pack. If the insulation is not installed to at least 1.6 lbs/ft^3, documented reasons must be included in the client file. Cellulose is the preferred insulation for dense packing walls, but fiberglass may be used.
4. Total voids of more than five percent will not be allowed by the New Mexico Energy$mart Program.
5. It may not be cost effective or practical to re-insulate stud cavities with existing fiberglass insulation. However, all walls with existing insulation should be inspected in at least three stud bays to check for complete coverage. Do not assume all walls or stud bays are insulated just because some are.
6. Cellulose shall not be used to insulate mobile homes.

6380 Plugs and Patching

1. Where possible, remove the exterior lap siding and drill the sheathing and/or sub-siding for the installation of insulation. Holes in the sub-siding (sheathing) must be patched. Various materials may be used for this patching, including wood plugs, plastic plugs, or spray foam insulation.

2. Holes drilled for an interior blow are to be covered by wooden chair rail or another acceptable manner and do not need to be sealed if dense pack of the cellulose insulation (3.5 to 4.5 lbs/ft^3) is achieved.
3. Surface drilling of the finished siding and plugging the exposed drill holes is an acceptable method when methods one and two above are not practical and the client/owner approves of this procedure in writing. Such documented approval shall be included in the client file.
4. Plugs compatible with the siding or wall type must be used to fill and cover the exposed surface that has been drilled.
5. Exposed plugs must be caulked and primed.
6. Any wood replaced as a result of the weatherization work that is exposed to the weather must be primed.
7. Stucco-sided dwellings may be insulated from the exterior or the interior. If insulated from the exterior, the stucco patch must match the existing stucco in texture and color.
8. Interior drill and blow techniques are preferred for homes with brick veneer siding.

6390 Quality Control

A final inspection to assess quality and quantity of wall insulation must be performed. This inspection can be performed by using a borescope, removing interior outlet and switch plates, using an infrared camera, or by other acceptable inspection techniques.

6400 Foundation and Crawlspace Insulation

This section addresses rim joist insulation, basement insulation, and crawl space insulation.

6410 Moisture Inspection and Repair

1. All dwellings must be inspected for problems associated with excess moisture.
2. Identification of potential moisture problems shall be documented in the client file.
3. Repair any moisture problems that will degrade or diminish the effectiveness of weatherization measures.
4. In crawl spaces with evidence of moist ground/floor, install a moisture barrier on the floor. This barrier should overlap at least six inches with joints sealed, and extend six inches up the crawl space wall. Note: If the entire dirt floor is not accessible, cover as much as possible.

6420 Defining the Thermal Boundary

The energy auditor must decide whether the first floor or the crawl space/foundation wall will serve as the air and thermal boundary. A lived-in basement would always be considered within the boundary, but unused basements and crawl spaces can be within or outside of the boundary. In some cases making this decision will be difficult. The information below is intended to set guidelines for defining the air and thermal boundary for an unoccupied basement or crawl space.

1. The crawlspace/foundation walls are the preferred air and thermal boundary under the following conditions:
   a. Good ground drainage and no existing moisture problems exist.
   b. An interior stairway exists between the house and basement.
   c. Ducts and the furnace are located in the basement.
   d. Foundation walls test tighter than the floor.
   e. Basement may be occupied in the future.
   f. Laundry facilities are located in the basement
   g. Heating equipment is located in the basement.
   h. Existing crawlspace/foundation vents can be sealed without affecting combustion equipment.
   i. Floor air sealing and insulation would be very difficult.
   j. A basement floor is concrete.
2. The floor above the crawlspace/basement is the preferred air and thermal boundary under the following conditions:
   a. Moisture or excessive dampness exist in the basement with no practical solution for mitigation.
   b. No furnace or ducts are present in the basement.
   c. Exterior entrance only.
   d. Dirt floor or deteriorating concrete floor.
   e. Badly cracked foundation walls.
   f. Excessive door and/or window repair is required in the basement.

6430 Storage Space

The client needs to be advised to remove any items so that the floors can be insulated effectively. The agency can work with the client in the event the client is incapable of moving the items as needed. Agency has the right to defer service until issue is resolved.

6440 Rim or Band Joist Insulation

1. Insulation must be at least R-13 in climate zones three, four, and five, and at least R-19 in climate zones six and seven; unless a NEAT audit calculation for the dwelling supports a different cost-effective level of insulation[8].
2. Fiberglass, rigid foam board, two-part foam, or other appropriate insulation may be used for this application.
3. If air leakage is significant, the band or rim joist area must be properly sealed before the insulation is installed.

[8] Please refer to *2099 New Mexico Energy Conservation Code* to find climate zone designations.

6500 *Floor Insulation*

6510 Inspection, Preparation, and Repairs

Precautions must be taken to ensure adequate combustion air is being supplied through non-operable vents for combustion appliances in crawl spaces or basements.

1. All units must be inspected for problems associated with excess moisture.
2. If floor insulation is installed over a crawl space area, the crawl space floor shall be covered with a moisture barrier of 6-mil plastic when conditions warrant. This polyethylene must be lapped at least six inches at the joints and taped and extended up the crawl space wall six inches and taped or otherwise sealed to the foundation wall.
3. Identification of potential moisture problems shall be documented in the client file.
4. Repair any moisture problems that will degrade or diminish the effectiveness of weatherization measures.
5. Repair any rotted, broken, or damaged structural components when appropriate.

6520 Installation Methods for Floor Insulation

1. All appropriate air sealing of the floor should be done before insulation is installed.
2. Insulation must be a minimum of R-19 in climate zones three and four, a minimum of R-30 in climate zones five and six, and a minimum of R-38 in climate zone seven; unless a NEAT audit calculation for the dwelling supports a different cost-effective level of insulation[9].
3. The insulation should be installed without voids or gaps. Fit insulation tightly around cross bracing and any obstructions.
4. Floor insulation must be fastened securely in place with wire fasteners, nylon mesh, or another appropriate method. Friction fitting or stapling floor insulation is not considered an appropriate method for securing the material. (*Floor insulation with a vapor barrier/retarder on all surfaces is acceptable.*)
5. Cellulose or blown fiberglass may be used as floor insulation if they are dense packed.
6. Do not support insulation with Tyvek, Typar, or other house wrap stapled to the bottom edges of the joists. Sheet materials that allow liquid water to drain through are acceptable materials, such as InsulWeb.
7. Do not use chicken wire or other metal mesh to support floor insulation.
8. Install insulation so that it is in contact with the underside of the sub floor above.
9. Ensure that floor insulation is in direct contact with the rim or band joints. If the dwelling is balloon framed, seal the bottom of the stud cavities prior to installing the insulation.
10. A crawl space clearance of less than 24 inches from the bottom of the floor joists to the ground is considered inaccessible.
11. Combustible material must be kept a minimum clearance of six inches from any combustion appliance or flue.

[9] Please refer to *2099 New Mexico Energy Conservation Code* to find climate zone designations.

6521 Materials

Fiberglass insulation is the preferred insulation material for a floor. New Mexico MFA recommends an encapsulated fiberglass batt or blanket for floors, such as Johns Manville ComfortTherm. This insulation is available with a vapor-barrier or non-vapor-barrier covering.

6522 Insulation Coverage

1. Floor insulation must be installed in a manner that provides as continuous a thermal boundary as possible.
2. Floor insulation must not be installed in a manner that excessively compresses the material.

6523 Ducts and Pipes

1. When floor insulation is installed, ductwork below the floor insulation must be appropriately sealed and insulated. Please refer to Section 8640 on page 89 for instructions.
2. When floor insulation is installed, water pipes below the insulation must be insulated as part of the floor insulation measure. Please refer to Sections 8700 on page 92.
3. Do not insulate over pumps, valves, pressure relief devices, or vents; do not insulate over heat tape unless the manufacturer's specification indicates that such installation is safe.

6600 Electrical Safeguards

1. Correct electrical problems such as unsafe wiring, open junction boxes, or other electrical code violations prior to performing any insulation work.
2. In attics, all visible electrical junction boxes shall be covered with an appropriate junction box cover and their location must be noted on the rafter above the box.
   a. All electrical fixtures shall be blocked with rigid material to ensure a minimum insulation clearance of three inches and a maximum clearance of six inches. Exceptions to this rule include Type IC (insulation contact) recessed lights and light/fan combinations, and closed junction boxes.
   b. It is permissible to permanently remove recessed light fixtures with client permission if this is the most practical method of air sealing. Be certain to observe all appropriate codes.
   c. It is permissible to replace non-IC type recessed fixtures with IC type if it is demonstrated to be cost effective.
3. Knob-and-tube wiring:
   a. If knob-and-tube wiring has been deactivated and the dwelling has been rewired with BX, NM, or other approved electrical cable, the attic may be insulated over the inactive knob-and-tube.
   b. Any insulation must be keep at least one inch from the live knob-and-tube wiring unless the wiring has been approved or upgraded by a licensed electrician.

4. In floors do not use any metal mesh material, such as chicken wire, to support floor insulation. This can cause an electrical hazard to the installers.

7000 Windows and Doors

7100 Primary Windows

7110 Window Assessment

1. All existing egress windows must remain operable.
2. Correction of preexisting code compliance violations is not an allowable cost except where weatherization measures are being installed.
   a. If a bedroom does not have a required existing code-compliant egress window, agencies are not required to install one only for reasons of code compliance.
   b. If a bedroom does not have a required existing code-compliant egress window and the agency intends to replace a window for reasons of saving energy, the replacement window must qualify as a code-compliant egress window. (In such cases, the difference between the cost of an exact type and size replacement and a qualifying egress window may be billed to health and safety.)
3. Non-operable windows may be permanently sealed against air leakage if agreed to by the client.
4. Window work on pre-1978 houses must be performed using lead safe weatherization procedures.

7120 Window Replacements

1. Window replacements must be based primarily on an energy-saving decision process (both single- and double-glazed) rather than on client requests or aesthetics.
2. Replacement, repair or installation is not an allowable health and safety cost, but may be allowed as an incidental repair or an efficiency measure if justified by the NEAT or MHEA audit.
3. The installation of replacement windows must meet applicable building codes.

7130 Window Air Leakage

Window tightening measures such as caulking and weatherstripping should only be done if it is demonstrated that the windows are leaking and there is reason to believe that air sealing measures will be cost effective.

7140 Window Repairs

1. When feasible, windows must be repaired rather than replaced.
2. Replace missing, broken, and severely cracked panes.
3. Window glazing compound shall only be replaced if the existing glazing is deteriorated to the degree that the window glass is in jeopardy of falling out of the sash.

4. Jalousie windows in pre-1976 mobile homes can be replaced if they cannot reasonably be repaired and are significantly leaking air, such as a broken-out glass or sash that does not seal to the frame and leaks badly. In this case, the replacements can be classified as air sealing measures rather than repairs.

7200 Storm Windows

7210 Interior Storm Windows

1. Due to the relative low cost of mobile home replacement windows, and the unlikelihood of cost-effective installation over good quality primary windows, replacement of a substandard window is generally preferred to the installation of a storm panel.
2. When interior storm panels are installed, they must be removable, the panels numbered, and the client educated to their removal, storage, and reinstallation. The supervisor must assess the ability of the client to comprehend this procedure and the likelihood that panels will be reinstalled correctly.
3. Self-storing insider storm windows can also be considered if MHEA justified.
4. Interior storm panels may be replaced or installed or primary windows may be replaced or installed, but both measures cannot be done to the same window unit.
5. A ½- to 2-inch air space between the prime window and the installed storm window is preferred.
6. Allowable storm windows meet the following specifications:
   a. Rigid-framed single- and double-strength glass.
   b. Rigid- and flexible-framed Plexiglas of at least 100 mils thickness.
7. Repairs to prime windows must be done to keep moisture out before an interior storm window may be installed over the prime window.
8. Storm windows must be securely fastened in place, installed straight, plumb, and level, and without distortion.
9. Storm windows must be installed with screws, placed at least every 16 inches, including one in each corner.
10. Metal storm windows should not come in contact with frames or fasteners constructed of dissimilar metals.
11. Installed storm windows in kitchens, baths, and other high moisture areas must be operable if they provide the only source of ventilation into the space.
12. Operable storm windows shall move freely.

7220 Exterior Storm Windows

1. Exterior storm windows can be installed as a last option when it is not cost beneficial to repair or replace the primary window and there is significant air leakage.
2. Storm windows are to be installed so that they function properly and do not interfere with the operation of the primary window.
3. All storm windows over 32 inches in width and/or 63 inches in height must be installed with a brace bar for stability.

4. Storm windows must be installed with screws placed at least every 16 inches including one in each corner.
5. A continuous bead of caulk must seal the storm window to the blind stop, or casing, without sealing the weep holes.
6. All exterior storm windows must have weep holes. If there are none, weep holes must be made.
7. A storm window should be installed so that there is less than a 2-inch dead-air space between the glass of the primary and storm windows.
8. A double-hung storm window is not to be used as a horizontal slider.
9. A double-hung storm window is not to be installed over a fixed prime window.
10. Clips used in shipping storm windows are to be removed after the storm windows are installed.

7230 Other Window Treatments

Tinted window films, all sun shields, and heat reflective materials are allowed if justified by NEAT or MHEA.

7300 Doors

7310 Door Assessment

1. Doors must be assessed for needed repairs, air leaks and comfort-related problems.
2. If there are two or more existing egress doors on the first floor, at least two must remain operable. At least one egress door on the second floor, if existing, must remain operable. Other doors can be sealed, if reasonable, with the client's permission.
3. Door work on pre-1978 houses must be performed using lead safe weatherization procedures.

7320 Exterior Door Replacements

1. Individual replacement doors are to be considered incidental costs.
2. Replacement doors may include one pane of glass if the replaced door had one or more pane.
3. Air leak mitigation measures for doors such as jamb-up kits, sweeps, and thresholds must be based on detection of leaks using the blower door.

7330 Door Repairs

1. When feasible, a door must be repaired rather than replaced.
2. Stuck doors do not have to be made operable unless they are to function as egress doors.

8000 Space Conditioning

8100 General Requirements

The efficient operation of heating and cooling systems is a critical aspect of efficient energy use. Replacing or repairing heating systems is allowed from an energy-efficiency or health and safety basis. Air conditioning system replacement, repair, or installation is allowed in homes of at-risk occupants where climate conditions warrant (please refer to Section 8500 on page 82 for more details). This section provides standards on the maintenance, repair, safety, efficiency improvements, and replacement of existing heating and cooling appliances.

8110 Space Conditioning Appliance Work Documentation

1. Each client file must include documentation of all efficiency work, adjustments, or replacements made to the water heating, space heating, and space cooling appliances.
2. Before the work on a combustion appliance or cooling appliance is complete, a representative of the agency must have finished a review of all combustion appliance forms and determined that the combustion appliance(s) meets the appropriate specifications.

8200 Space Heating Appliances

8210 Combustion Efficiency

Acceptable combustion analysis, post-cleaning and tuning, values are found in Table 8-1.

1. The steady-state efficiency pre-cleaning and tuning of all heating system should be checked to determine whether it needs cleaning and tuning.
2. Replace the heating system if the applicable conditions are met (see Section 8400 on page 77).

Table 8-1

Acceptable Combustion Test Analysis Values Post-Cleaning and Tuning				
Heating Unit Type	***Oxygen (O_2)***	***Carbon Dioxide (CO_2)***	***Net Stack Temp.***	***Smoke Test***
Gas				
Atmospheric (Category I)	4 – 9%	Natural 9.6 – 6.8% LPG 11.2 – 7.8%	300-600º F	NA
Fan-assisted (Category I)	4 – 9%	Natural 9.6 – 6.8% LPG 11.2 – 7.8%	300-480º F	NA
Condensing (Category IV)	See man. Info.	See man. Info.	See man. Info.	NA
Standard Power Burner	4 – 9%	Natural 9.6 – 6.8% LPG 11.2 – 7.8%	300-650º F	NA
Oil (No. 1 & 2)				
Oil gun burner (low-static pressure)	4 – 9%	12.5 – 8.8%	325-600º F	2 or less
Flame Retention burner (low-static pressure)	4 – 7%	12.5 – 10.3%	325-600º F	2 or less
High Static Pressure burner	See man. Info.	See man. Info.	See man. Info.	See man. Info.

8220 Forced Air Systems

Modifications and repairs, when possible, should meet the following specifications (applicable to type) and/or comply with the follow-up procedures. The qualified technician must document each situation in which any of the following specifications cannot be met:

1. *Gas-fired unit requirements*
    a. *Gas Leaks*: All identified gas leaks should be referred to appropriate persons for repair or replacement. Refer to Section 13820 on page 124 for gas leak testing procedures.
    b. Flexible gas lines must be replaced in the following conditions:
        i. The line is badly kinked, corroded, shows signs of physical wear, or enters an air handler cabinet.
        ii. The line connection is the soldered, two-piece type.
        iii. The line was manufactured before 1973. Sometimes there is a metal ring on the flexible line that is dated. If there is no dated metal ring, use one of the first two criteria listed just above.
    c. *Cleaning and tuning:* All gas-fired units should be cleaned and tuned once every two to three years. Suggest the client have this service performed regularly.
2. *Oil-fired unit requirements*
    a. *Oil storage and piping*: Check the oil tank and piping for leaks and compliance with all appropriate codes.

b. *Cleaning and tuning*: All oil-fired units should be cleaned and tuned annually. Make sure the client is having this service performed regularly.

3. *Thermostat/gas valve*: The heating system must have a thermostat in working condition that is compatible with the control circuit type (24 volt vs. millivolt). For 24-volt systems, the anticipator on the thermostat should be set equal to the measured control circuit amperage. Non-electric setback thermostats with an adjustable anticipator may be installed under the following conditions:
   a. The client's lifestyle indicates the potential for energy savings.
   b. The client is receptive to the installation.
   c. The client is provided appropriate education on the operation of the thermostat.
4. *Fan on/fan off control*: Ideally, the fan-off temperature is between 95° and 100°F but never below 80°F. The fan-on target range is between the fan-off temperature and 130°F but never to exceed 140°F.
5. *Limit switch*: This switch should shut the burner off at approximately 200°F where appropriate.
6. *Blower belts and pulleys*:
   a. Cracked or broken blower belts shall be replaced.
   b. If a larger pulley is installed on a belt drive furnace blower, the motor amperage must be measured. If the amperage draw is more than the motor's rated amperage, a smaller pulley must be installed, and the motor amperage measured again.
7. *Filter*: A clean furnace filter should be installed with an extra left for the client. If an extra filter is left with the client, it must be documented.
8. *Blower or air handler*: The air handler/blower should be visually inspected to determine if it requires cleaning. If necessary, it should be cleaned. The motor and blower must be oiled (where applicable).
9. *Other cleaning*: Other necessary cleaning should be done, including air intakes, burners, furnace controls, heat exchangers, the blower compartment and return air plenum, registers, and grilles.

8230 Air Handler Pressure Balance Testing

Air handler and pressure balance test procedures shall be done on all central furnace systems. These tests include the whole house test procedure and the room-to-room test procedure. Refer to Section 13400 on page 118 for the details of these procedures.

8240 Measurement of Furnace Heat Rise

Excessive heat rise can result from low air handler fan output (wrong fan speed, bad motor bearings, low voltage, dirty blower, wrong fan rotation, slipping or broken fan belt); low airflow from restrictions is ductwork; or an over-fired burner. Low heat rise can result from excessive fan speed, excessive duct leakage, or an under-fired burner.

The temperature rise must be measured on all central furnaces. Refer to Section 13500 on page 119 for the details of testing.

8250 Measurement of Ductwork External Static Pressure

If the external static pressure (ESP) is too high, the airflow might be blocked or the ductwork might be too small or restricted. The higher the ESP, the lower the airflow within the ductwork. If the ESP is too low, the ductwork might be very leaky or the blower might be dirty or working improperly.

The external static pressure must be measured on all central furnaces. Refer to Section 13500 on page 119 for the details of testing.

8260 Space, Wall, and Floor Furnaces

Space, wall, and floor furnaces should conform to the following standards:

1. *Gas-fired unit requirements*: Please refer to Section 8220 on page 70, Forced Air Systems.
2. *Oil-fired unit requirements*: Please refer to Section 8220 on page 70, Forced Air Systems.
3. *Thermostat/gas valve*: Please refer to Section 8220 on page 70, Forced Air Systems.
4. *Limit switch*: Gravity furnaces must be equipped with a working high limit switch that shuts the fuel supply off at approximately 250°F.
5. *Filter*: If the manufacturer intended that the appliance have a filter, it should be checked for cleanliness. If a filter was not intended by the manufacturer, one shall not be installed.
6. *Other cleaning*: Please refer to Section 8220 on page 70, Forced Air Systems.

8270 Mobile Home Sealed Combustion Furnaces

For the purposes of this section, a sealed combustion furnace means a central heating unit that exhausts its combustion gases through the roof and receives its combustion supply air through the roof also, the exhaust air and supply air passing through a concentrically arranged vent pipes.

All sealed combustion mobile home furnaces should conform to the following specifications:

1. *Gas-fired unit requirements*: Please refer to Section 8220 on page 70, Forced Air Systems.
2. *Oil-fired unit requirements*: Please refer to Section 8220 on page 70, Forced Air Systems.
3. *Thermostat/gas valve*: Please refer to Section 8220 on page 70, Forced Air Systems. (*It is preferred that mobile home thermostats be located on an interior wall.*)
4. *Fan-on/fan-off*: Ideally, the fan-off temperature is between 95° and 100°F, but never below 80°F. The fan-on target range is between the fan-off setting and 130°F, but

must never exceed 140°F. In addition, all appliances that are not direct-vent combustion type and have inaccessible flue pipes must have a spillage test done to verify that there is no significant spillage. Please refer to Section 13860 on page 125 for spillage testing details.

5. *Limit switch*: This switch should shut the gas valve off at approximately 200°F, where appropriate.
6. *Heat rise*: Furnace heat rise should fall within the manufacturer's recommended temperature range. If this information is not available, the heat rise should fall within a 40° to 80°F range. The furnace must not cycle on the high-limit switch. See Section 8230 on page 71 for heat rise test procedures.
7. *Filter*: A clean furnace filter should be installed with an extra left for the client. No filters shall be installed on furnaces that do not have separate heat exchanger/blower compartments (International and Intertherm brands).
8. *Blower or air handler:* The air handler/blower should be visually inspected and cleaned if necessary. The motor and blower must be oiled (where applicable).
9. *Other cleaning*: Other necessary cleaning should be done, including air intakes, burners, furnace controls, heat exchangers, the blower compartment and return air plenum, registers, and grilles.
10. *Non-sealed combustion furnaces*: These units should be replaced with sealed combustion furnaces.
11. Steady-state efficiency of sealed combustion mobile home furnaces may be tested by the following methods:
    a. From the termination of the vent on the roof, ensuring that no dilution air enters the test sample and that an accurate combustion supply air temperature is read by the combustion analyzer.
    b. By drilling the double-wall vent connector and sampling combustion gases from the inner exhaust vent. Make sure an accurate combustion supply temperature is read by the combustion analyzer from the space between the inner and outer vents. The hole drilled through the two-pipe connector must be carefully caulked and lagged after the test.
12. Carbon monoxide emissions of sealed combustion mobile home furnaces may be tested by the following methods:
    a. From the termination of the vent on the roof, ensuring that no dilution air enters the test sample.
    b. By drilling the double-wall vent connector and sampling combustion gases from the inner exhaust vent. The hole drilled through the two-pipe connector must be carefully caulked and lagged after the test.
13. Ambient carbon monoxide concentrations should be measured. If any level of CO above 9 ppm is found, the source must be identified and the problem corrected.

8300 Health and Safety Measures for Combustion Appliances

With the use of blower door technology and dense pack sidewall insulation, houses are being sealed tighter than ever before. In accordance with the "house-as-a-system" approach to weatherization, there might be existing indoor air quality conditions and combustion venting problems that may be intensified by air sealing activities. As a result, the following health and safety tests and inspections apply to all homes to be weatherized.

8310 Vent System Inspection

An inspection of the vent system must be completed to ensure that the proper size and type of venting pipe is used, the condition of the vent pipe is satisfactory, and the clearances meet applicable codes. Ensure that the vent system is unobstructed. Use Table 8-2 below for guidance. Refer to appropriate codes and manufacturer's instructions, if appropriate.

Table 8-2

Vent Types and Required Clearances		
Gas	**Oil**	**Solid Fuel**
24 gauge single-wall galvanized six inches from combustibles	24 gauge single-wall galvanized 18 inches from combustibles	24 gauge single-wall black pipe 18 inches from combustibles
B-vent and BW-vent 1 inch from combustibles	Smoke pipe Type L double- wall PMI from combustibles	Smoke pipe Type L double-wall PMI From Combustibles
Approved thermo-plastic for 80+ and 90+, 0 to 5 inches from combustibles PMI	Metalbestos all-fuel pipe 2 inches from combustibles	Metalbestos all-fuel pipe 2 inches from combustibles
Schedule 40 for 90+ condensing 0 inches from combustibles PMI	Stainless steel flexible liner must be installed as a kit	Stainless steel flexible liner must be installed as a kit
Flexible flue liner kit, must be installed as a kit	Residential vents must have a single acting barometric damper -.04 inches WC	
All horizontal sections of vent must have a ¼ inch per foot slope down to the appliance.		

1. Mobile home combustion vents:
   a. There are no approved gas non-direct-vent furnaces for mobile homes; however, there are some non-direct-vent water heaters. These will be clearly marked "Approved for Mobile Home Installation" and will have certain installation requirements.
   b. Prior to 1976 mobile home furnaces got combustion air from underneath the mobile home by a duct or hole in floor. These furnaces had a single wall flue pipe.
   c. Post-1976 mobile home furnaces must be sealed combustion. A sealed combustion mobile home flue is a double wall concentric vent stack that routes flue gasses out through the inner stack and draws combustion air from the roof down between the inner and outer vent pipes.
   d. Vent repairs or replacements should be done according to applicable codes.

8320 Appliance Clearances

Check for adequate clearance of space heaters, furnaces, and flues from combustion materials. If the clearance is not sufficient, corrective action must be taken to ensure all

applicable codes are followed. Refer to appropriate codes and manufacturer's instructions if appropriate. The clearances for solid-fuel appliances should comply with NFPA 211.

8330 Combustion Supply Air for Heating Appliances

For non-direct-vent appliances, identify the combustion air source and make sure it is unobstructed and sufficient as defined by the appropriate NFPA code. Use the method below to meet code requirements for combustion supply air:

1. The minimum volume of the combustion appliance zone (CAZ) is 50 ft^3 per 1000 Btuh input rate of vented combustion appliances in the CAZ.
2. If combustion supply air is not adequate, correct the situation with the guidance of NFPA 31 (oil), 54 (gas), or 211 (solid fuel).

8340 Gas and Oil Leaks

Gas leaks can be dangerous and are literally a total waste of energy. Additionally, natural gas and LPG act as a greenhouse gas that is as much as twenty times more potent than carbon dioxide. Check for gas leaks on all natural gas and LPG gas appliances and supply lines. Check for natural gas leaks above fittings; check for LPG leaks below fittings. All gas leaks must be repaired before any work is done. Verify gas leaks with a soap solution (note: do not use soap solution on flexible CSST tubing). Refer to Section 13820 on page 124 for gas leak testing procedures. If a gas leak is found follow these steps:

1. Severe gas leaks: Shut down the main gas valve at the gas meter if it is outside.
   a. Inform the client and leave the dwelling.
   b. Contact the fuel supplier and have the problem fixed.
2. Moderate gas leaks: Contact the fuel supplier and have the problem fixed. If this is not possible or appropriate:
   a. Tighten the pipes and fittings (with gas supply off).
   b. Ensure that all materials and sizes comply with NFPA and local codes.
3. All gas leaks must be fixed before weatherization work begins. Document leaks and repairs in the client file. Gas leaks on buried lines outside the house/thermal envelope are not the responsibility of the Weatherization Program, but can be repaired when feasible.
4. Oil supply lines and components must also be checked for leaks. If leaks are found, repair in accordance with NFPA and local codes.

8350 Venting System Spillage and Draft

Spillage, draft, and depressurization testing must be done before and after the weatherization job is complete, since air sealing work can have an effect on proper venting. Testing at the end of each day – intermittent testing – during the weatherization work is required when measures are done that reduce natural air leakage (for example, air sealing or installation of dense pack insulation) or may increase negative pressure within the dwelling (for example, installation of exhaust fans). Crew chiefs or final inspectors must conduct intermittent testing. With the combustion appliance zone (CAZ) under worst-case

depressurization conditions, test for spillage after one minute of burner operation on all non-direct-vented combustion appliances that have a negative pressure in their vent connectors. If spillage occurs or if the draft is not adequate, determine the cause and mitigate the hazard. Refer to Section 13860 on page 125 for spillage and draft testing procedures.

Because approved mobile home furnaces are direct-vent, sealed combustion units, spillage and draft testing are not required. Direct-vent, Category III, and Category IV appliances in site-built homes do not require spillage or draft testing.

8360 Carbon Monoxide Emissions, Ambient and Flue Gas

Carbon monoxide is a hazardous gas that is a common byproduct of both vented and unvented combustion. Testing for CO must be done to ensure the safety of clients and workers:

1. Ambient CO testing:
    a. Upon entering the job site living space, an ambient CO reading must be taken. If any level of CO above 9 ppm is found, the source must be identified and the problem corrected.
    b. An ambient air test for CO must be taken around solid-fuel appliances (if circumstances permit), unvented heaters, and gas cook stoves. If any level of CO above 9 ppm is found, the source must be identified and the problem corrected.
    c. Post-weatherization CO readings must be taken and documented to ensure that weatherization measures did not exacerbate and existing CO problem.
    d. If during any testing procedures, such as combustion safety testing, the ambient CO level becomes 35 ppm or higher, the testing shall be stopped and the area purged with fresh outdoor air. Before testing continues, the source of this CO must be mitigated.
2. In all vented combustion appliances, a CO test of undiluted flue gases must be done. If levels are above 100 ppm as-measured in the undiluted flue gas sample, corrective action must be taken to reduce the CO to lower acceptable levels. Record of this must be included in the client file.
3. For gas oven bake burners, CO must be checked at the oven vent termination in a sample of undiluted combustion gas. The reading must be less than 100 ppm as-measured or 800 ppm air-free. The CO emissions increase and then peak just after burner start up, levels then fall to a momentary plateau before the burner shuts down as part of the duty cycle. The reading CO ppm must be taken during this stable plateau.
    a. If readings are higher than those stated above, corrective action must be taken. Please refer to Section 13840 on page 124 for testing procedures.
    b. If readings are detected above these levels, follow these steps:
        i. Immediately inform the client and include documentation in the client file.
        ii. Determine the source(s) and cause(s) of the problem and document reading(s).
        iii. At this point no weatherization work is to begin.

iv. A plan of action is to be determined based on the skill level of the crew and implemented to correct the problem before any weatherization work can continue. This may involve using a contractor.
v. If for some reason the client refuses the corrective action, the job is to be deferred and a written explanation documenting the reason inserted in the client file.

8370 Combustion Safety Testing

All oil- and gas-fired furnaces, boilers, and water heaters – with the exception of direct-vent units – must be tested with worst-case depressurization test procedures. Please refer to Section 13860 on page 125 for more information.

8400 Central and Space Heater Replacement

Every effort will be made to repair the existing heating unit before replacement is considered. Replacement will be allowed only when the unit cannot be cost-effectively repaired or made to operate safely. Every effort must be made to get the maximum efficiency possible with an existing installation. Inspections must be done to ensure that wiring and chimneys are in good condition and that there are no obvious code violations. All efficiency measures must be performed and documented.

8410 Replacement and Repair of Heating Systems, General

Replacement of a heating system (furnace, boiler, or space heater) is allowed when one of the following conditions exists:

1. The heat exchanger is cracked and a new one cannot be located or is cost prohibitive to install.
2. The replacement of the system is justified by an analysis done with NEAT or MHEA.
3. The unit design is very inefficient or the unit is grossly oversized (justified by Manual J[10], NEAT, or MHEA), resulting in high heating bills or combustion air, venting, or clearances that cannot meet national, state, and local codes. Note: Sizing procedures must take into account derating for altitude. Refer to Section 8430 on page 78 for site-built home heating system derating and Section 9210 on page 93 for mobile home furnace derating.
   a. A grossly oversized unit can be replaced under two conditions:
      vi. The existing unit is 40 percent or more oversized based on Manual J, NEAT or MHEA,
      vii. If an existing unit is suspected of being 40 percent or more oversized and/or has an input greater than 100,000 Btu/hr. Written sizing justification must be included in the client file before it can be replaced.
4. Weatherization work causes the existing heating unit to become grossly oversized based on Manual J, NEAT, or MHEA.

[10] The full title of Manual J is *Residential Load Calculation*, 7th edition, by the Air Conditioning Contractors of America (ACCA).

8420 Replacement Heating System Sizing

All gas, oil, and electric replacement units must be sized according to Manual J, NEAT, or MHEA.

1. Documentation of heating system sizing must be included in the client file.
2. Replacement heating systems should not be oversized by more than 25 percent.
3. If the calculated size is not locally available, using the next higher size appropriate for the job is permissible.
4. Sizing procedures must take into account derating for altitude

8430 High Altitude Adjustment[11]

1. If a dwelling is located at a site with an altitude greater than 2000 feet, its furnace must be derated at a rate of four percent per 1000 feet. This is because there is less oxygen at higher altitudes, so fuel-rich combustion results if the burners are not derated (gas flow reduced).
2. Consult with the manufacturer before any derating is done. Derating is usually accomplished by installing a smaller orifice in each burner.
3. Some Category I, fan-assisted furnaces do not require derating because the induced-combustion fan is able to supply enough oxygen-depleted air to allow the combustion to take place at the proper fuel/oxygen ratio. Check with the manufacturer.

8440 Heating System Replacement Efficiencies

1. Furnace replacements must have an annual fuel utilization efficiency (AFUE) of greater than 90 percent. Agencies must obtain a waiver from MFA when installing a furnace with an AFUE less than 90 percent.
2. Contact the New Mexico MFA before any boiler replacement.

8450 Space Heater Replacement, Excluding Solid-Fuel Appliances[12]

1. Space heaters with low steady-state efficiencies must be replaced if justified by NEAT or MHEA. Space heaters can also be replaced if there are other conditions present that may justify replacement, such as health and safety considerations, multiple space heaters being replaced by one unit with significantly less Btu/hr input, or other factors listed below. The justification must be documented in the client file. Replacement space heaters must be direct-vent units. If an agency wishes to install a replacement space heater that is not a direct-vent unit, a waiver from MFA is required.
2. In homes where unvented space heaters are the primary heating source and there is no repairable existing vented heat source, the agency must install a vented heating system whenever reasonably possible. If this is not possible, no weatherization work

[11] Based on the *National Fuel Gas Code*, NFPA 54.
[12] Based on DOE Space Heater Policy, WPN 08-04.

may be done. This policy is based on the fact that weatherization of the dwelling will result in the probability of increased moisture and indoor air quality issues resulting from an unvented space heater.

3. New Mexico MFA strongly encourages removal of all unvented gas- and liquid-fueled space heaters and replacement with vented, code-compliant heating systems as a prerequisite to weatherization. However, unvented gas- or liquid-fueled space heaters may remain as secondary heat sources in single-family houses provided they comply with local codes. Funds may not be used to replace unvented secondary space heaters. Any unvented gas- or liquid-fueled space heaters that remain in a single-family house after weatherization shall met the following specifications:
   a. Shall not have an input rating in excess of 40,000 Btu/hour.
   b. Shall not be located in, or obtain combustion air from sleeping rooms, bathrooms, toilet rooms, or storage closets except as follows:
      i. Where approved by the authority having jurisdiction, one listed wall-mounted space heater in a bathroom with an input rating that does not exceed 6,000 Btu/hour, is equipped with an oxygen-depletion sensing safety shut-off system, and the bathroom meets required volume criteria to provide adequate combustion air.
      ii. Where approved by the authority having jurisdiction, one listed wall-mounted space heater in a bedroom with an input rating that does not exceed 10,000 Btu/hour, is equipped with an oxygen-depletion sensing safety shut-off system, and the bedroom meets required volume criteria to provide adequate combustion air.
   c. If any unvented kerosene heater is left in the dwelling after weatherization, including a newly installed unit, a Homeowner Consent Form must be completed and put in the client file. Client education must be provided on the limited use of the unvented space heater.
4. Any space heater replacement or repair procedure should include inspection to ensure that working smoke and carbon monoxide detectors are installed on the same floor as the space heater. In instances where smoke and carbon monoxide detectors are not present or are not operating properly, new detectors may be purchased and installed with DOE funds.
5. DOE policy does not allow fuel switching except on a limited case-by-case basis. An exception to this rule is with unvented kerosene heaters, where fuel switching is allowed when practical. Specific replacement and fuel types are discussed below.
6. Electric space heaters: DOE does not allow repair, replacement, or installation of stand-alone electric resistance space heaters.
7. When an unvented space heater is replaced, the old heater must be removed from the dwelling.

8460 Solid-Fuel Heating Systems

If an installation does not maintain the minimum recommended clearances (see below and NFPA 211) from all unprotected combustible walls, ceilings, or floors, then remediation to meet these clearances shall be performed before other weatherization work proceeds. The client shall be notified of any unsafe conditions.

If an installation contains a chimney connector of less than 22 gauge metal, contains a creosote buildup of ¼ inch or more, does not have a smoke and carbon monoxide alarm, remedy these deficiencies before weatherization proceeds.

1. No wood stove may be exhausted into an unlined masonry chimney. Chimney work is an allowable expense: however, if needed chimney work is not addressable with existing program funds, such wood stove configurations shall be disconnected and the chimney penetration sealed before other weatherization work can proceed.
2. The following NFPA 211 requirements must be used for all solid-fuel heating system installations.
    a. Triple-wall or insulated double-wall vent connector pipe must be used within two inches of combustible materials.
    b. Double-wall vent connector pipe must be used within 18 inches of combustibles and must be kept at least nine inches from combustibles.
    c. Single-wall vent connector pipe must be kept at least 18 inches from combustibles.
    d. If necessary, provide combustion air from outdoors to reduce negative pressure around solid-fuel appliances.
    e. Single-wall solid-fuel appliances must be kept at least 36 inches from combustibles.
    f. Stoves installed closer than 36 inches to combustibles must be double-wall, or combustibles must be protected by ventilated, non-combustible wall protectors.
    g. Stove clearances of less than 36 inches must be specified by the manufacturer and printed on a metal tag attached to the stove.
    h. For further information, refer to NFPA 211.
3. Wall and floor heat protection requirements.
    a. Wall and ceiling protection must be at least 26-gauge (0.013 inch) sheet metal with 1-inch spacers or other approved material.
    b. Floor protection must be:
        i. If there is at least 18 inches of open air space between the bottom of the solid-fuel appliance and the floor, use at least 24-gauge (0.024 inch) sheet metal.
        ii. If there is between six and 18 inches of open air space between the bottom of the solid-fuel appliance and the floor, the floor protection material should be ¼ inch cement board covered with 24-gauge sheet metal.
        iii. If there is less than six inches of open air space between the bottom of the solid-fuel appliance and the floor, the floor should be protected with four-inch thick masonry blocks arranged with the holes interconnecting and open to allow free air circulation through the floor protector. The hollow masonry should be covered with 24-gauge sheet metal.
4. Replacement vent connectors shall be single- or double-walled stovepipe of at least 22 gauge. Each joint must be secured with at least three sheet metal screws or equivalent fasteners with joints facing in the proper direction. Vent connector material installed in the living space of a dwelling unit must be either black or stainless steel.

Galvanized vent connector shall not be used in a living space because it emits toxic zinc vapors when heated.

5. Chimneys should be mechanically cleaned using a wire brush and rods manufactured for this purpose. Any stiff wire brush may be used to clean vent connector material. Chemical chimney cleaning products are not an allowable expense in the Energy$mart Program.

8470 Solid-Fuel Appliance Replacement Policy

Solid-fuel appliances are defined as those that burn wood (cord or pellet) and coal. Solid-fuel appliances include heating stoves, ducted gravity furnaces, and forced air furnaces. The venting and clearances of existing installations must be made, when reasonably possible, to comply with the current edition of NFPA 211. Repairs are preferred to replacements.

1. Replacement or repair of a solid fuel appliance is allowed only when client health and safety is a concern. All replacements must comply with the current NFPA 211.
2. There may be situations where the costs of a new installation or the repair of an existing installation may be too expensive for the Energy$mart Program to incur.
   a. In some cases, the owner may have to be responsible for some or all of the costs for making a solid fuel appliance installation safe.
   b. In situations where an owner is responsible for making any health and safety repairs a Homeowner Consent Form must be completed with an addendum describing each problem to be corrected. A copy must be left with the owner and a copy becomes a part of the client file.
3. Cost of repair and replacement of solid fuel appliances are to be charged to health and safety.
4. Replacement of solid fuel gravity furnaces, forced air furnaces, and boilers will not be permitted and are considered beyond the scope of weatherization. However, repair of existing units will be permitted.
5. Solid-fuel appliances in mobile homes: Replacement of solid-fuel appliances in mobile homes must be mobile home approved direct-vent stoves. Mobile home solid-fuel stoves and approved venting systems are expensive. The material costs for these measures can easily exceed the targeted percent of the total material cost for the job allotted for health and safety, so careful consideration must be given to the replacement of mobile home solid-fuel appliances.

8480 Subcontracting Heating System Work

Agencies using contractors for any heating system replacement are responsible for verifying and documenting that the heating system needed to be replaced, was properly sized using Manual J, NEAT, or MHEA, that the installation complies with all national, state, and local codes, and that all Energy$mart Weatherization heating system (including duct measures and standards) policies and procedures were followed. Agencies are responsible for ensuring that all mandatory health and safety testing and post-weatherization documentation is in the client file.

8500 *Space Cooling Appliances*

Air conditioning system replacement, repair, or installation is allowed in homes of at-risk occupants where climate conditions warrant. In climate zone three (Las Cruces), medical eligibility for an air conditioner is needed for anyone under the age of 60. In all other climate zones in New Mexico, medical eligibility is required for any occupant, regardless of age.

In addition, service providers must request prior authorization for installation or replacement of air conditioning system.

8510 Window Space Cooling Units

1. Replacements must be justified by a NEAT or MHEA energy audit.
2. For inspection, proceed with the recommendations below:
   a. Initial indoor inspection of room unit:
      i. If connected with an extension cord, is it adequate for unit load. An extension cord cannot be more than 10 feet for a 120 volt unit, and not greater than six feet for a 240 volt unit.
      ii. Inspect service panel to insure adequate load capability for unit and dwelling.
      iii. Check filter for condition. Educate client on importance of proper maintenance.
      iv. Check the condition of the evaporator coil. Clean and straighten fins if necessary.
      v. Check to verify that front of unit is unobstructed. It is best if the unit has 20 inches top, bottom, and sides.
      vi. Educate the client on the proper maintenance of the unit.
   b. Outdoor inspection of room unit:
      i. Inspect the condition of the condenser coil. Clean and straighten fins if necessary.
      ii. Inspect the unit support(s) for condition. Verify permanence and air tightness of unit in the opening.
      iii. Check for proper clearances around the outside of the unit. It is best if the unit has 3 ½ feet top, bottom, and sides.
      iv. Verify that the condensate from the evaporator is properly drained.

8520 Central Space Cooling Equipment

1. Replacements must be justified by a NEAT or MHEA energy audit. New Mexico MFA may be consulted if recommended by the audit.
2. Remove the cover of the fan compartment with the power off and visually inspect the components and cabinet condition.
3. Check all registers for condition and ease of operation. Replace as necessary.
4. Perform mobile home duct leakage tests and seal according to New Mexico Energy$mart Standards. Please refer to Sections 5500 on page 46, 13700 on page 122, and 8620 on page 87.

5. Check for proper insulation on ducts running through unconditioned areas. Seal and insulate to R-8 were necessary.
6. In some cases, when mobile homes have central air conditioning added to the furnace ductwork, an air-pressure controlled damper is installed (sometimes just under the furnace) to regulate the flow of heated or cooled air. Occasionally this damper will stick, thereby preventing the free flow of heated or cooled air. If this happens in a client's dwelling, money may be expended to repair this cooling/heating damper.
7. For central system indoor units (evaporator coil):
   a. Replace existing filter with reusable filter and leave one extra with the client. Educate the client on how to change the filter.
   b. Check the condition of the fan for cleanliness. Clean the fan if needed.
   c. Inspect the evaporator coil for cleanliness and fin condition. Clean if necessary and straighten damaged fins.
   d. Check condition of drainage pan and drain line and to verify that they drain properly to the outdoors and away from the dwelling.
   e. Check for leaks around indoor coil and at connections.
8. For a central system outdoor units (condenser coil):
   a. Inspect for cleanliness, condition, and drainage and other factors that would affect performance or cause damage to the unit.
   b. Inspect insulation on suction line. Replace insulation if damaged. Visually inspect lines for crimps and leaks around fittings.
   c. Check to see that the unit has the proper clearances to allow maximum airflow around and through the unit.
   d. Check to verify that the unit is located so that it will not be damaged by client activities.
   e. Outdoor unit should be installed on a level base.
9. Unused or non-functional central air conditioning coils should be removed to increase air handler airflow.

8530 Evaporative Coolers

The energy used by an evaporative cooler is only from 10 to 25 percent of the energy needed to operate a comparably-sized refrigerant air conditioner; additionally, they are much less expensive to replace.

Common types of evaporative coolers in New Mexico include single-stage (direct evaporative coolers) and two-stage (indirect/direct evaporative coolers). The single-stage type is by far the most common. The single-stage type is often classified in two additional ways, depending on the material within which water is converted to water vapor, thereby cooling the hot outdoor air before it enters the dwelling:

1. Fiber pad coolers usually use aspen wood fibers (sometimes called "excelsior") packed in plastic netting. There are other types of synthetic fiber pads, but few perform as well as aspen. These pads should be replaced every year or two in order to maintain the efficiency of the cooler.

2. Rigid-sheet pad coolers use a stack of corrugated sheets that allow the water to flood the air-inlet side where most of the evaporation takes place. Although these pads are significantly more expensive than aspen pads, they last much longer.

8531 *Weatherization Measures*

1. *General Measures*:
   a. A plastic cover should be installed over the interior evaporative cooer vent. It should be installed with clips to allow easy removal and replacement. Inform the client of how to remove and replace the cover. It should be removed during the summer months.
2. *Systems with Their Own Dedicated Ductwork*:
   a. Seal all accessible ductwork (inside and outside conditioned space) with UL-181 approved duct mastic and mesh tape.
   b. Insulate all accessible ductwork located outside the thermal/pressure envelope with appropriate insulating and air-barrier materials. Insulation shall be a minimum of R-4.
   c. Install rigid, sealed covers over all register locations as nearly aligned with the primary air-barrier (pressure boundary) as possible. The registers are usually near the ceiling.
   d. Deliver a homeowner's maintenance guide to evaporative coolers along with sufficient aspen pad material for replacement.
3. *Systems Sharing Ductwork with a Furnace:*
   a. Seal all accessible ductwork (inside and outside conditioned space) with UL-181 approved duct mastic and mesh tape.
   b. Insulate all accessible ductwork located outside the thermal/pressure envelope with appropriate insulating and air-barrier materials. Insulation shall be a minimum of R-8.
   c. Whenever possible, replace upper damper sealing method (installed during heating season) with an automatic damper system locate as near to the furnace as possible.
   d. Deliver a homeowner's maintenance guide to evaporative coolers along with sufficient aspen pad material for replacement.

8532 *Suggested Periodic Service*

Evaporative coolers should be periodically serviced by a knowledgeable technician in order to maximize efficiency and lifespan. The following items are recommended:

1. Significant equipment alterations include:
   a. Install a low-voltage thermostat on coolers that have no thermostat.
   b. Replace single-speed motors with two-speed motors.
2. Service for aspen-pad coolers should be performed once each year, usually at start up in the spring or early summer. Service items should include:

a. Cleaning the wet section of the cooler (pump or pumps, pad, water distribution line, water pan):
   i. Remove dirt and minerals in the pump area.
   ii. Remove dirt and minerals in other wet areas of the cooler.
   iii. Inspect the pads and wash or replace, as required. Slightly oversized pads are acceptable, undersized pads should never be used.
   iv. Clean the water distribution line so that water flows through it freely. If necessary, replace the line.
   v. Clean the water pump baskets. If the cooler is equipped with a purge pump, clean it also. If the water flow from the pump is inadequate after cleaning, replace the pump.
   vi. Clean the water pan at the bottom of the unit. Inspect for rust. Add a rust preventative to extend the life of the cooler.
   vii. Inspect and adjust the float value for proper operation. Replace and adjust if necessary. Submersible pumps should have a float switch lockout.

b. Service of the dry section of the cooler (electrical, blower housing, blower wheel, bearings, pulleys, belts):
   i. Inspect electrical connections and any controls to ensure they are safe and working properly.
   ii. Check the condition of the blower housing. Look for rust and scaling.
   iii. Inspect the blower wheel for wear, rust, and corrosion.
   iv. Lubricate all moving parts according the manufacturer's recommendations, including use of the appropriate lubricant.
   v. Pulleys should be cleaned and checked for proper alignment and smoothness.
   vi. Belts should be inspected and replaced if needed. Belt tension should allow ½ to ¾-inch deflection at the center of the span when pushed with a thumb. Check the amp draw of the motor and adjust the sheave diameter and belt tension accordingly.

8540 Heat Pumps

1. Upon arrival at the job site, do the following for split and packaged systems:
   a. Ask the client about any heat pump related problems during the heating and cooling season.
   b. Ask if there is a service contract or if the unit has been serviced recently and, if so, does the client know what was done.
   c. Find out what maintenance is regularly performed by the client and how often.
   d. Determine the type of system, locate its components, and note the condition of each.

e. Remove the cover of the fan compartment with the power off and visually inspect the components and cabinet condition.
f. Note information on the data plate regarding proper breaker size, wire gage and lengths. Installation should conform to data plate. If not, note problems.

2. For a split system heat pump indoor units:
   a. Replace existing filter with reusable filter and leave one extra with the client if the assessor has been provided with extra filters per agency rules.
   b. Check the condition of the fan for cleanliness. Clean if needed.
   c. Inspect the evaporator coil for cleanliness and fin condition. Clean if necessary and straighten damaged fins.
   d. Check condition of drainage pan and drain line and to verify that they drain properly to the outdoors and away from the dwelling.
   e. Check for leaks around indoor coil and at connections.
3. For a split system heat pump outdoor units:
   a. Inspect for cleanliness, condition, and drainage and other factors that would affect performance or cause damage to the unit.
   b. Inspect insulation on suction line. Replace insulation if damaged. Visually inspect lines for crimps and leaks around fittings.
   c. Check to see that the unit has the proper clearances to allow maximum airflow around and through the unit.
   d. Check to verify that the unit is located so that it won't be damaged by client activities.
   e. Outdoor unit should be installed level and on a base.
4. For a split system heat pumps, perform these efficiency measures:
   a. Check all registers for condition and ease of operation. Replace as necessary.
   b. Perform mobile home duct leakage tests and seal according to Energy$mart Standards. Please refer to Sections 5500 on page 46, 13700 on page 122, and 8620 on page 87.
   c. Check for proper insulation on ducts running through unconditioned areas. Seal and insulate were necessary.
5. For a packaged heat pumps:
   a. Check the condition of the fan for cleanliness. If fan needs cleaning, take amp draw and note reading. Clean the fan and retake amp draw reading to verify fan motor is in good condition.
   b. Inspect the both coils for cleanliness and fin condition. Clean if necessary and straighten damaged fins.
   c. Check condition of drain pan, drain trap, and drain line to verify that they drain properly to the outdoors and away from the dwelling.
   d. Visually inspect lines for crimps and leaks around fittings.

8600 *Ducted Distribution Requirements*

Making the heating unit safe and efficient, while important, is only part of making the entire heating system as effective as possible. The condition of the delivery system will define the amount of heat that is actually delivered to the dwelling. A detailed inspection of supply and return ducts for air leaks or blockages must be made and all problems corrected. Do not attempt to repair/seal ductwork on which asbestos is present.

Ductwork treatment is dependent on a number of factors, including its location, accessibility, its impact on dwelling pressures, and its condition.

8610 Ductwork Inspection, Cleaning, and Sealing

1. Ductwork must be tested and sealed according to Section 5500 on page 46 and Section 13700 on page 122.
2. Existing flex duct must be adequately supported without sags. Additional support is often needed.
3. Delivery and return ductwork must be cleaned as necessary to remove large objects and debris that may impede airflow through the heating system.
4. Uncover any blocked registers or grilles. Explain to the client the importance of maintaining the unrestricted airflow.
5. As necessary, supply registers and return air grilles must be removed and cleaned to remove excessive dirt and debris that may impede airflow.
6. When appropriate, remove and block off ducts, registers, and grilles located in unconditioned spaces.
7. Ductwork outside the thermal envelope of the dwelling must be sealed with mastic and insulated.
8. All accessible return air ductwork within a combustion appliance zone (CAZ), except gravity systems, must be sealed enough to eliminate the potential for backdrafting.
9. Ducts and registers into non-living areas of the structure may be sealed off with the owner's permission as long as system efficiency is not compromised.
10. Existing crawl spaces used as plenums should be abandoned and replaced with a sealed duct system.

8620 Duct Sealing

1. Gaps larger than ¼ inch between the air handler and adjoining ductwork or equipment will be bridged with sheet metal.
2. Other accessible duct joints, cracks, seams, holes, and penetrations shall be sealed as specified below:
   a. Surfaces will be properly cleaned before sealing.
   b. Seams, cracks, holes, and penetrations less than ¼ inch will be sealed using fiberglass mesh and mastic.
   c. Seams, cracks, holes, and penetrations between ¼ and ¾ inch will be sealed in two stages:

i. They will be backed using temporary tape – duct tape – as a support prior to sealing;
ii. They will be sealed using fiberglass mesh and mastic. Fiberglass mesh and mastic shall overlap the temporary tape by at least one inch on all sides.

d. Seams, cracks, holes, and penetrations larger than ¾ inch shall be repaired using rigid duct material.
i. Fiberglass mesh and mastic shall overlap the repair joint by at least one inch on all sides.

3. Installation of mastic will be applied in a manner that meets manufacturer specifications, as well as UL 181M, NFPA 90A and NFPA 90B.
4. In mobile homes, if the boot is loose to the floor, it shall be reattached to the subfloor with roofing nails or staples. Wood screws may also be used. Ensure that the heads of the screws do not prevent the register or grille from fitting properly into the boot.
a. If gaps exist between the boot and the floor, fill the gaps with mastic or other appropriate materials. It may be necessary to use a cleaning solvent such as mineral spirits or denatured alcohol to eliminate any greasy buildup to ensure the duct sealing material will adhere properly.

8630 Ductwork Sealing Materials

1. Cloth duct tape shall never be used for duct sealing.
2. Existing duct tape must be removed before installing duct mastic or other approved sealing materials
3. Mastic shall meet the following requirements:
a. Non-toxic and water-resistant.
b. UL listed and labeled per UL 181A or 181B standards.
c. Shall be compatible with the duct material to which it is applied.
4. Mesh fabric used to reinforce duct mastic shall meet the following requirements:
a. Comply with the mastic manufacturer's specifications.
b. Made of fiberglass.
c. Have at least a 9 x 9 weave per inch.
d. Be at least 0.006 inches in thickness.
5. For flexible ductwork:
a. UL 181 BM listed tapes and mastic products will be used to seal the interior liner.
b. All accessible joints, seams, and connections will be sealed with UL 181 approved mastics.
c. Vapor barrier of all duct insulation will be taped to the flex duct using the taping system required by the manufacturer of the duct insulation.
6. Ducts shall be properly fastened and supported to prevent leakage:
a. Metal-to-metal duct joints will be fastened with a minimum of three equally spaced screws.

b. Flexible-to-metal duct joints will be fastened with tie bands using a tie band tensioning tool.
c. Duct board to duct board joints will be fastened with a clinch stapler.
d. Duct board to flexible duct joints will be fastened with a metal take-off collar.
e. Metal plenum to air handler cabinet joint will be fastened with a minimum of three equally spaced sheet metal screws.
f. Flexible duct and duct board shall be supported every four feet using at least a 1 ½-inch material.
    i. Support materials will be applied in manner that does not crimp the duct or reduce the interior dimensions of the duct.
g. Metal ducts shall be supported by metal strapping, rods, or other standard materials.
h. Duct supports shall conform to the duct manufacturer's installation instructions and must be corrosion resistant.

8640 Ductwork Insulation

1. Active ductwork outside the thermal enclosure must be repaired if damaged, then sealed and insulated.
    a. Prior to installing insulation, ductwork must be sealed according to these Standards.
        i. Exception: Inaccessible parts of the distribution system do not require thermal insulation. "Inaccessible" means nearly impossible to insulate because of location or obstructions.
2. Supply and return ducts and plenums located within the thermal/pressure enclosure do not require thermal insulation.
    a. Exception: There might be cases where duct insulation is appropriate if within the thermal enclosure, such as a basement. For example, if there is not adequate heat getting to a room, the branch duct may be insulated for reasons of thermal comfort as long as the following items have been checked and/or implemented first:
        i. There are no branch duct obstructions to airflow.
        ii. The branch duct balancing damper is fully open.
        iii. The branch duct air leakage has been checked and sealed, if necessary.
3. Combustion vents should not be insulated.
4. For ductwork that is not within the thermal enclosure of the dwelling, install a minimum of R-8[13] on ducts and plenums.
    a. If ductwork is already insulated to a level of R-4 or greater, no additional insulation is required, however, make appropriate repairs to the existing insulation, including checking for duct air tightness.
    b. Burying sealed ductwork in attic insulation is acceptable as long as the ductwork has an effective R-8.
5. Insulation must have a flame spread rating no greater than 25.
6. It is best to use vinyl-backed, reinforced foil duct wrap, or two-part foam on ducts.

[13] Based on *2009 New Mexico Energy Conservation Code*, Section 14.7.6.14.

7. The duct insulation should be installed with the vapor barrier on the outside, which will serve to cover the insulation. Any ductwork used for space cooling should have the vapor barrier taped at joints.
8. Do not wrap duct insulation so tightly that it is excessively compressed. It should not be compressed more than 50 percent of normal thickness.
9. Maintain proper clearance between duct insulation and combustion appliance flues.
10. Install protective covering around the insulation where required by local regulations.
11. Ducts with existing asbestos insulation must not be disturbed.

8650 New Ductwork Installations

1. New ductwork should not be installed unless absolutely necessary.
2. Ducts, supply registers, and return grilles should be sized and selected according to the latest editions of *Residential Duct Systems*, Manual D, by ACCA; *Residential Comfort System Installation Standards Manual* by the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA); or a comparable industry-accepted method.
3. Attempt to install all new ductwork within the thermal/pressure envelope.
4. Do not install ductwork within exterior walls.
5. Building frame cavities, closets, crawl spaces, and chases must not be used as ducts. However, ductwork may be housed by, or pass through these spaces.
6. Ductwork must be installed at least four inches from any bare earth.
7. New ductwork installations may not include panned joists or stud cavities for ducts. All passageways for distribution air must be hard ducted; panned floor joists may not be used.
8. A crawl space may not serve as a distribution plenum.
9. Do not use a dropped ceiling cavity as a plenum.
10. Flex duct can be used if more cost-effective to do so.
    a. Sections must be joined with a metal connection, mechanically fastened, and sealed at all joints. Flex duct must be supported according to manufacturer's specifications.
    b. Flex duct must be supported according to manufacturers' specifications. Insulation mesh works very well for this purpose.
    c. Flexible ductwork must not be bent to more than a 45 degree angle without the use of a rigid elbow.

Pressure pan testing must be done in some dwellings to determine if new ducts installed outside the thermal/pressure envelope are leaking to or from the outdoors. Refer to the Section 8660 on page 90 for more information.

8660 Duct Leakage in Site-Build Homes

1. New Mexico Weatherization requires combustion safety testing before and after weatherization to determine whether the furnace air handler significantly influences the pressure in the CAZ. To conduct this test, measure the pressure in the CAZ with reference to the outdoors with the furnace air handler off and then on.

a. If the air handler significantly affects the pressure in the CAZ, call for the appropriate duct sealing on the job work order to mitigate the hazardous condition.

2. For ducts located in unconditioned spaces follow these steps:
   a. If possible, convert the unconditioned space where the ducts are located to a conditioned space, making sure the air and thermal barriers are installed effectively.
      i. Demonstrate the effectiveness of this weatherization work by performing a house-to-zone pressure and flow test (if possible) before and after converting the unconditioned space to a conditioned space.
      ii. Always repair disconnected ducts in the space.
      iii. It is preferred to seal the shell of the space rather than sealing the duct joints.
   b. If the unconditioned space is impossible to convert to a conditioned space or it is determined impractical to convert to a conditioned space follow these steps:
      i. Use a pressure pan to determine duct leakage spaces outside of the thermal/pressure envelope. Refer to Section 13720 on page 122 for instructions.
      ii. Repair, seal ducts with mastic, and thermally insulate ducts in unconditioned spaces to at least an R-8.
3. For ducts located in conditioned spaces, such as a basement or crawlspace follow these steps:
   a. Always repair disconnected ducts or ducts that are significantly leaking. Adhere to combustion safety testing recommended above in number one.
   b. Visually inspect the conditioned space to ensure that the shell is properly insulated.
   c. If it is determined that weatherization work should be done to the shell of the conditioned space housing the ducts, perform a house-to-zone pressure and flow test (if possible) before and after the work to quantify the effectiveness of the work.
   d. A number of techniques can be used to help find hidden leaks in ductwork. These methods include:
      i. Careful visual inspection.
      ii. Operating the air handler while searching for leaks. Existing leaks often become leakier if the conditioned basement or crawl space is opened to the outdoors.
      iii. Pressure pan testing at registers and grilles while the blower door is operating and the basement or crawl space is opened to the outdoors.

8670 Duct Leakage Standards, Mobile Homes and Double-Wides

1. If there is a belly return system in the mobile home or double-wide, convert it to a central return (living-space-system) (refer to Section 9800 on page 96, Belly Return Conversions).
2. Inspect the ductwork visually, and then seal all penetrations in the duct trunk line, boots, and seal the ends of the duct run.

3. When the above duct sealing work is completed conduct a pressure pan test on all duct registers including the furnace plenum.
4. If the furnace plenum is accessible, it must be sealed.
5. If the sum of the pressure pan readings is greater than six Pascals or an average of 0.7 Pascals per register, whichever is higher, the furnace plenum and branch ducts must also be accessed and sealed.
6. If the sum of the pressure pans readings is equal to or less than six Pascals or an average of 0.7 Pascals per register and all penetrations in the duct trunk line (boots, end of trunk line, visible penetrations) with the exception of the furnace plenum connection have been sealed, the task may be considered acceptable.
7. The ideal leakage is 0 pa and 0 CFM leakage to the outside using the pressure pan. Technicians should strive to reduce all leakage as much if possible.
8. A duct blower may also be used to test the ductwork. If this procedure is used, the task may be considered complete if the CFM leakage to the outside, measured at 25 Pa, is less that 10 percent of the total floor space. For example; if a mobile home is 14 x 66, the area is 924 square feet. The Duct Blaster™ reading must be less than 10 percent of the floor area of 924, or 92.4 CFM.

8700 Piped Distribution Requirements

Treatment of distribution pipes for hot water is dependent on a number of factors, including its location, accessibility, and its condition.

8710 Steam and Hot Water Heat Distribution Pipes

1. Make certain there are no leaks in hot water distribution pipes.
2. Supply and return lines in spaces outside of the thermal enclosure must be insulated if they are accessible.
3. Pipes may be insulated within the habitable space if it is determined that the space does not require heating or is overheated.
4. Pipe insulation must be sized to the pipe being insulated.
5. Secure the pipe insulation with mechanical fasteners or appropriate tape.
6. Pipe insulation must have mitered cuts at corner joints. Tape joints appropriately.
7. Pumps, valves, pressure relief devices, or vents should not be insulated. Do not insulate over heat tape.
8. Closed cell foam, high temperature rated insulation or elastomeric pipe insulation should be used that has a flame spread rating no greater than 25.
9. Maintain the manufacturer's recommended clearance between pipe insulation and combustion appliance flues.

9000 Mobile Home Requirements

The same general procedures described in all other sections of these Standards shall apply to mobile homes unless otherwise stated, or stated more specifically in this section.

9100 General Inspection

An auditor will perform an inspection of the mobile home gathering the following information and testing:

1. Relevant dimensions of the dwelling.
2. Health and safety Issues.
3. Existing R-values and cavity depths.
4. Structure soundness.
5. Air leakage.
6. Indoor air quality and installation of smoke and CO detectors, where applicable.
7. Moisture problems.
8. Ventilation systems.
9. Heating appliance(s) efficiency.
10. Cooling appliance(s) efficiency.
11. Client equipment-use problems.

Upon completion of the inspection and tests, the auditor will develop a work scope by using MHEA or another acceptable computer energy auditing tool. If it is determined that measures should be completed in an order other than those listed by MHEA for health and safety or other reasons, it must be documented in the client file.

9200 Heating Systems

Satisfy all requirements of Section 8000 starting on page 69, Space Conditioning.

9210 High Altitude Adjustment[14]

1. If a mobile home is relocated to a site with an altitude greater than 2000 feet above its previous location, its furnace must be derated at a rate of four percent per 1000 feet. This is because there is less oxygen at higher altitudes, so fuel-rich combustion results if the burners are not derated (gas flow reduced). For example, if a mobile home furnace is near sea level and it is relocated to 3000 feet, its burners must be derated by 12 percent.
2. Consult with the manufacturer before any derating is done. Derating is usually accomplished by installing a smaller orifice in each burner.
3. Some Category I, fan-assisted furnaces do not require derating because the induced-combustion fan is able to supply enough oxygen-depleted air to allow the

[14] Based on the *National Fuel Gas Code*, NFPA 54.

combustion to take place at the proper fuel/oxygen ratio. Check with the manufacturer.

9300 *Moisture Problems*

1. If moisture problems exist in the ceiling or sidewalls, insulation should not be added until the moisture source and/or site of penetration, including leaks, is identified and eliminated. Refer to Section 41300 on page 31 for more information. Identify if there are pressures that exacerbate moisture problems and find a solution to the problem.
2. Exhaust-fan ducts terminating in ceiling cavities, crawl spaces, or other areas, shall be extended to the outdoors and sealed to prevent exhaust air from re-entering the conditioned space.
3. Dryer vents shall be vented to the outdoors. If the mobile home is skirted, the dryer vent termination must be to the outdoor side of the skirting.

9400 *Electrical Inspections*

The electrical wiring in pre-1978 manufactured homes is sometimes aluminum. This aluminum wire, when in contact with other metals that are normally part of an electrical system, can cause galvanic corrosion and shorting. As a result of this possibility, in pre-1978 manufactured units special care should be taken.

1. Before insulating mobile homes, inspect and assess the electrical wiring as follows:
    a. If the mobile home has electrical wiring made of aluminum, a licensed electrician must inspect the home before any weatherization is started. After the weatherization work has been completed, the electrician must inspect the wiring again. Documentation of these inspections and their results must be in the client file.
    2. Care must be taken to ensure that electrical wiring was not damaged during insulation work. The energy auditor should also determine if the electrical system is working properly before weatherization. This can be done by testing electrical outlets and switches before and after completing the work.

9500 *Air Leakage Reduction Requirements*

1. Perform initial blower door test before any work is done to the mobile home. Repair any obvious, major leaks, utilizing the blower door to direct efforts.
2. Refer to Section 5000 on page 43 for air sealing guidelines.
3. In mobile homes concentrate on the following air sealing areas:
    a. Ductwork sealing.
    b. Insulation preparation work and insulation installation.
    c. Major repairs to the air barrier and thermal boundary.
    d. Air sealing work that is necessary to block moisture migration into ceilings and walls.
4. In addition to the leakage areas noted in number three above, major air leaks should be addressed first, including the plumbing chase behind the washer and dryer, the water heater closet, under the bath tub, and around the electric service entrance conductor. Air leak mitigation measures that enhance client comfort (for example, installing a storm

window near a reading chair, installing a jamb weatherstrip kit on a door near a reading chair, etc.) must be documented with a brief explanation in the client file.

5. Snap fasteners, weatherstripping, and/or drip caps shall be used whenever possible to reduce air and/or water leaks around primary windows.
6. When accessible, the joint (marriage wall) between the two sections of a double-wide must be filled and sealed from underneath the structure. When it is not possible to seal from the exterior, interior trim should be removed and the leaks should be sealed from the interior. This leakage is commonly found in archways and doors in the center of the double-wide dwelling.
7. Air leaks in water heater closets with an exterior wall must be sealed with care taken not to seal off combustion air from the outside. If the gas water heater is a Category I, natural draft unit, the wall between the water heater and the interior of the dwelling must be sealed.
8. Continue air sealing until it is no longer cost effective.

9600 General Insulation

Insulation shall be installed only in areas of the mobile home envelope that separate conditioned from unconditioned space.

All wooden materials installed on the exterior of a unit that will be exposed to the weather must be pre-primed unless there are extenuating circumstances. Documentation justifying the use of unprimed materials must be included in the client file.

9700 Ceiling Insulation

1. The ceiling and roof condition must be inspected and assessed before installing insulation.
2. If it is cost effective, ceilings that appear weak shall be repaired or reinforced—especially in heavy snow load areas—before installing insulation.
3. Recessed lighting fixtures and fan/light combinations that are Type IC (insulation contact) rated by UL may be covered with insulation. Thermal insulation shall not be installed within three inches of fan/light fixtures or recessed light fixtures that are not rated Type IC.
4. Ventilation fan (not fan/light combination) housings and ducts may be covered with insulation if all holes and penetrations are sealed with a nonflammable sealant. Fans must remain operational.
5. All mobile home flues and chimneys must be listed for use in mobile homes to assure adequate clearances are maintained.
6. Blocking around combustion appliance vents is required when insulation is installed, except where combustion air is pulled through a pipe that surrounds the combustion appliance vent pipe (concentric pipe system). Follow the manufacturer's recommendation for clearances between vents and combustible insulation. Air seal around vents following the manufacturer's specifications.
7. Ceiling insulation must be fiberglass and installed in a manner that ensures complete coverage over heated or cooled areas. Ceiling cavities should be blown to a density of 1.6 pounds per cubic foot (approximately R-4 per inch). It is useful to use a bag-count method to determine the total amount of insulation to install.

8. Mobile home ceilings shall not be insulated with cellulose or over-filled with loose fiberglass so as to create structural problems in the ceiling.
9. If fiberglass insulation is installed between the original roof and the added framed roof, ensure that there is no roof venting between the mobile home ceiling and the original mobile home room. If such venting is left it place it effectively short circuits the added insulation between the original and added framed roofs.
10. If an interior fiberglass drill-and-blow method is used for installing insulation, holes must be plugged and sealed properly. The holes must be straight and equidistant. In addition, there must be an access hole in each cavity to ensure complete coverage. In most mobile homes, two access holes per cavity are preferred for a more even coverage.
11. If an exterior or side-opening (edge lift) installation method is used, all roof penetrations and areas of potential leakage must be sealed with elastomeric sealant (when compatible with roof materials) or another equivalent sealant, as necessary. Areas that are to be patched must first be cleaned down to the metal roof surface. After insulation, reattach existing gutters with screws that are one size larger than the original screws. The edge lift method is the preferred method to insulate mobile home ceilings.
    a. If the roof requires a new coating after this insulation work, make sure the roof is strong enough to support workers. Temporary walking boards are recommended rather than walking on the roof itself.
12. Installing insulation from the ridge of the roof is allowed.
13. If an end gable blow is utilized, steps must be taken to ensure complete and adequate coverage is achieved. Attention to areas behind gussets, trusses, edges and corners is critical. Access to the gable end should be achieved by removing siding. Drilling and cutting is not an allowable method for access. If this method is used, the reasons for not using the methods listed in numbers 11 and 12 above must be documented in the client file.
14. In heavy snow load areas, educate the client whenever ceiling insulation is added, explaining that the depth of snow on the roof could increase because of reduced heat loss. To minimize the possibility of creating leaks, clients should be advised to refrain from shoveling snow off the roof. Instead, they should use a push broom, and only if absolutely necessary.

9800 Sidewall Insulation

9810 Sidewall Insulation Requirements

1. Mobile home sidewalls should be insulated when the MHEA audit software shows it is cost-effective.
2. If the wall insulation thickness is less than the cavity depth, the apparent R-value must be reduced by at least 25%. The R-value may be decreased by more than 25% if the installation is of very poor quality and does not come in contact with all six sides of the cavity. If the R-value is reduced by more than 25% the reason must be documented in the file.
3. The exterior siding and the interior wall materials must be inspected prior to the installation of insulation.

4. Weak or damaged wall materials must be repaired or reinforced prior to installing insulation. Pictures and other items hanging from the walls must be removed before installing the insulation.
5. Installing insulation above windows and doors is usually not feasible or cost-effective and is not required in mobile homes.

9820 Sidewall Insulation Methods

1. Vinyl faced fiberglass batt insulation (batt-stuff method) and loose fill fiberglass are the preferred insulation materials for mobile home sidewalls. Select the method that will take the least amount of time to install. If it is important to install a vapor barrier, use the batt-stuff method.
2. For cavities that cannot or should not be insulated with the batt-stuff technique, the fill-tube method with loose fill fiberglass is recommended.

9900 Ductwork

1. General:
    a. Fiberglass (with the exception of duct board) shall not be left exposed on the inside of ductwork.
    b. Visually inspect registers, boots, and the trunk where there is any evidence of air leakage or blockage.
    c. Repair any missing, loose-fitting, disconnected, or blocked ductwork. Repair work is warranted if there is restriction or blockage of the duct that restricts air flow, even if there is no indication of air leakage.
    d. Properly seal all detectable air leaks in duct system.
    e. Inspect, test, and repair, if necessary, the connection between the furnace plenum and the main duct run.
    f. Trunk-end stops are only necessary if it is determined that the installation will reduce duct air leakage.
        i. End stops shall be made from sheet metal or aluminum valley flashing placed a minimum of 12 inches beyond the last register opening in order to retain balanced airflow. If 12 inches is not possible, the minimum must be four inches. Gaps between the stop and the duct must be sealed with mastic.
        ii. It is allowed to block the end of the trunk with polyethylene-encased fiberglass. This plug should be placed a minimum of 12 inches beyond the register opening. Seal the plug to the duct surfaces with mastic to ensure no air leakage remains. Use a pressure pan test to verify an air-tight seal.
    a. Closable registers with vanes are not allowable. Existing closable registers must either be replaced with non-closable registers or have the operable part removed.
    b. Flat non-reinforced registers are not allowed.
    c. Floor registers must not be mechanically fastened to the floor except for situations where they may become a tripping hazard to the client.

d. Please refer to Section 8600 on page 87, Ducted Distribution Requirements, for more information. Also refer to Section 13700 on page 122 for duct leakage testing procedures.

2. Belly Return Conversions:

e. Mobile home belly return air systems must be permanently sealed from the occupiable space. A central return air system must be created by the following methods:

i. Installing an adequately sized return air grille(s) in the furnace closet door.
ii. Sealing the return grilles in the floors of bedrooms, bathroom, kitchen, living area, etc.
iii. Sealing the return air grille in the furnace closet floor.
iv. Undercutting doors, adding door or wall registers, or installing jump registers in the attic in a manner that reduces the room-to-room pressure difference (with the door closed and the air handler operating) to three Pascals or less.

f. For a discussion of duct leakage measurements and standards, follow the instructions in Section 5500 on page 46.

g. For ductwork sealing and insulation, follow the instructions in Section 5500 on page 46.

3. Crossover duct repair and treatment:

h. Crossover ducts shall be repaired or replaced in a manner that prevents compression or sharp bends, minimizes stress at connections, avoids standing water, and avoids long runs. When there is no skirting, the crossover duct shall be protected against rodents, pets, etc., and properly suspended above the ground. If replacement is needed, replace with hard line duct and insulate to R-8.

i. Flexible crossover ducts shall have a minimum R-8 insulation. They shall be secured with mechanical fasteners (for example, stainless steel worm drive clamps, plastic/nylon straps applied with a tightening tool, etc.) and sealed with mastic or a comparable pressure-sensitive tape.

j. Existing flexible crossover duct with an insulation R-value of four or less which has been damaged may be replaced with new foil-faced flexible duct with R-8 insulation.

k. The crossover duct must be replaced if the inner lining is brittle or made of mesh. If in doubt, replace it. In many cases, a leaky crossover can be repaired by cutting out the section of duct containing the leak. A fabricated sheet metal sleeve can be inserted between the remaining pieces of crossover duct. The metal sleeve must be attached to the flex duct crossover using ratcheting plastic straps.

l. Crossover ductwork must be appropriately secured above the ground. It may be supported by strapping or blocking.

m. Flexible duct shall not be allowed to sag more than 12 inches over a span of eight feet.

n. Flexible duct must be foil faced since it is located in an unconditioned space.

91000 Floor (Belly) Insulation

1. Floor Insulation Requirements:

a. Repair and seal ducts before insulating the floor.
b. Belly rodent barriers must be inspected for general condition, structural strength, and major air leaks prior to installing insulation.
c. Make necessary belly rodent barrier repairs even if no additional insulation will be added, or if holes in the belly allow significant air movement between the belly cavity and the outside.
d. Belly cavities must be inspected to determine the location of the plumbing, any plumbing leaks, the R-value of existing insulation, and the cavity depth. Additionally, determine if the mobile home has a hanging belly (floor joists run from one side of the dwelling to the other) or flat belly (floor joists run the length of the dwelling). Leaks should be fixed prior to weatherization.
e. Belly insulation shall be installed only after all repairs have been made, major holes in the rodent barrier and floor have been sealed, and all ductwork has been sealed according to Section 5500 on page 46.
f. Belly insulation must be installed in a manner that ensures complete coverage of all heated areas.
g. Holes that have been made in belly rodent barriers for the installation of insulation must be patched and sealed or one section of a three-tabbed shingle can be put into the cavity at the tube access point before insulating, and then moved into place to cover the slit in the belly after the insulation is installed.
h. Bellies shall not be dense-packed or over filled so as to create undue stress on the belly rodent barrier.

2. Floor Insulation Methods:
   a. Loose fill fiberglass shall be the insulation material for mobile home bellies.
   b. Bellies that hang up to eight inches or less below the floor in the center area should be filled entirely with insulation blown at the required densities.
   c. Bellies that are greater than eight inches below the floor at the center area should be insulated using the perimeter method. If possible, leave space between water pipes and the floor to reduce the likelihood of frozen pipes.
   d. The preferred method for insulating bellies is from the edge.
      i. When insulating a hanging belly (floor joists run from one side of the dwelling to the other), a 2 ½- or 2 9/16-inch hole should be drilled in each cavity. A rigid pipe or tube should be inserted to the opposite wing. The wings should be dense packed with fiberglass (1.6 pounds per cubic foot) and the center should be loose-filled (not dense packed).
      ii. When insulating a flat belly (floor joists run the length of the dwelling), appropriately sized holes should be drilled in each end cavity and dense packed with fiberglass to 1.6 pounds per cubic foot. The center sections must be completed from under the belly.
   e. When insulation is installed from underneath the belly, it is preferred that the first person to go underneath install a 6 mil vapor barrier on the ground in order to reduce health risks to the installers from animal feces.
   f. Make belly patches durable and secure by using adhesives, clinch staples, screws, and lath strips whenever possible. Large belly patches in the center of the belly should be made so that water will not accumulate in the event of a water leak.

g. Insulated sheathing board, fiberboard, and nylon-reinforced belly bottom material specifically manufactured for mobile homes are the preferred patching materials for large holes in belly rodent barriers. Soft patching materials that may be used include Tyvek and Typar. Patches should be adhered with silicon or other durable caulk and then stapled with clinch staples.

h. Ductwork must be inspected for insulation that might have accidentally been installed inside the ductwork during insulation work.

i. Upon completing insulation work, rim joists that have been drilled shall be plugged with an appropriate plug. The plug shall be sealed in the hole with an adhesive compound.

91100 Insulation of Water Supply Systems

1. Water pipes that have not been protected from freezing with under-floor insulation should be insulated to a minimum of R-3.
2. The piping shall be free from water leaks and properly secured to support the weight of the piping and insulation.
3. The insulation product may be either a) flat and capable of being molded to the outside of the pipes, or b) preformed to fit standard pipe diameters. If the product is preformed, dimensions shall be appropriate for the pipe size. Do not use fiberglass pipe wrap except in situations where preformed foam pip wrap will not conform to the existing plumbing.
4. If the insulation is exposed to the weather, it shall be resistant to degradation from moisture, ultraviolet light, and extremes in temperature, or a jacket or facing shall be installed that protects the insulation from these conditions.

91200 Water Heaters and Their Closets

1. At a minimum, water heaters in closets with an exterior wall must be treated as follows:
   a. The tank should be wrapped with an insulation blanket. Please refer to Section 10140 on page104 for instructions.
      i. Large holes in the closet walls that allow air leakage into the interior living area must be sealed.
      ii. All plumbing within the closet that is susceptible to freezing must be insulated.
      iii. An adequate amount of combustion air must be provided to gas water heaters.
   b. If it is not possible to wrap the water heater with insulation, the exterior access door and adjacent exterior walls of closets containing electric or gas water heaters should be insulated, if possible. If the door and adjacent wall can be insulated, the water heater shall not be wrapped with insulation.
      i. Cover any air vents in the door or adjacent exterior wall ***and***
      ii. Bring combustion air from underneath the belly or through any skirting by installing an appropriately sized metal or PVC chute with a rodent barrier when there is not a concentric, sealed combustion flue bringing combustion supply air in from the outdoors.
2. When treating a water heater closet that houses a non-direct-vent gas water heater, air seal and insulate the interior walls and provide adequate combustion air.
3. Insulate the first six feet of cold and hot water pipes to/from the hot water tank. Insulate any other cold water pipe exposed to freezing temperatures. Maintain clearances from combustible pipe insulation with gas water heaters.

4. Set hot water temperature to 120°F at the faucet nearest the water heater and educate client about how this will save energy, but might force shorter showers. If a dishwasher is present set the temperature to 140°F unless the dishwasher has a pre-heater.
5. Install low-flow showerheads when shower flow whenever possible and cost effective.

91300 *Combustion Systems*

1. If interior combustion air is used for the furnace, it must be replaced with a sealed combustion (direct-vent) furnace.
2. All fuel-burning, heat-producing appliances in mobile homes, except ranges and ovens, must to be vented to outside. Further, all fuel-burning appliances in mobile homes, except ranges, ovens, illuminating appliances, clothes dryers, existing solid fuel-burning fireplaces and existing solid fuel-burning fireplace stoves, must be installed to provide for the complete separation of the combustion system from the interior atmosphere of the manufactured home (i.e., to draw their combustion air from outdoors).
3. For replacement of solid-fuel burning appliances, please refer to Section 8470 on page 81.

Optional measures should be evaluated on a case-by-case basis. When these measures prove cost-effective, they may be installed.

91400 *Inside Storm Window Installation*

1. The MHEA should be used to justify installation.
2. Panels must be removable, the panels numbered, and the client educated to their removal, storage, and reinstallation. This measure should not be done unless the energy auditor is assured by the client that they will maintain and reinstall panels correctly.
3. Self-storing insider storm windows can also be considered if MHEA justified.

91500 *Baseload Electricity Reduction*

Electric baseload measures, as described in Chapter 10000 on page 103, are to be considered for mobile homes, including refrigerator replacements, compact fluorescent light bulbs, and low-flow showerheads.

10000 Baseload Measures

The energy used by electric or gas appliances that is not related to space heating or cooling is called baseload energy. Usually the baseload use is consistent from month to month. Baseload energy includes lighting, refrigeration, water heating, cooking, washer and dryer, and electronics.

10100 Water Heaters

Generally energy use for water heating is the largest part of baseload energy use. The energy used for water heating can be reduced in a number of ways, including insulating the storage tank and distribution pipes, lowering the hot water temperature, and using less hot water.

10110 Water Heater Inspection

All gas-fired water heaters must meet the following specifications:

1. All identified gas leaks should be referred to the appropriate person for repair. All gas leaks should be documented in the client file.
2. All water heaters must be properly vented.
3. All fossil-fuel water heaters, with the exception of direct-vent units, must be tested with worst-case depressurization test procedures (see Section 13800 on page 123).
4. All gas-fired direct-vent (sealed combustion) and atmospheric combustion water heaters must be tested for carbon monoxide emissions. Measured carbon monoxide levels must be equal to or less than 50 ppm, or 100 ppm air-free.
5. All water heaters must have a water temperature test. If the water temperature is above 120ºF at a faucet near the water heater, the client should be informed about the advantages and disadvantages of lowering the water temperature. If the client agrees to an adjustment, lower the water temperature to 120ºF. Mark the old setting on the control as a reference point.
6. Visually inspect the combustion chamber for rust, dirt, and proper burner alignment. Visually inspect the venting, plumbing, and gas piping. Check the tank for water leaks and note any code violations.
7. Inspect the temperature/pressure relief value to determine if it is installed correctly.

10120 Domestic Hot Water Pipes

1. Make certain there are no leaks in domestic hot water pipes.
2. Insulate the first six feet of hot water pipe and the first six feet of cold water pipe with ¾-inch pipe insulation.
3. Closed cell foam, high temperature rated insulation or elastomeric pipe insulation should be used that has a flame spread rating no greater than 25.
4. Maintain a minimum of six inches between pipe insulation and all heat sources.
5. Domestic hot water pipes running through unconditioned spaces must be insulated if accessible.

10130 Water Heater Replacement and Installation

1. Accepted industry procedures and practices will be followed for water heater removal and replacement.
2. Replacement electric water heaters must have an energy factor of at least 0.92. Replacement gas heaters must have an energy factor of at least 0.62.
   a. Replacement or repair is allowed where client health may be a concern.
3. An emergency drain pan will be installed a minimum of four inches above the floor. A ¾-inch drain line, or larger, will be connected to tapping on the drain pan and run to a drain or pumped to daylight.
4. A steel bladder expansion tank will be installed on the cold-water side.
5. Temperature/pressure relief value, dielectric unions, and backflow prevention will be installed according to the manufacturer's specifications.
6. The following will be checked once the new system has been filled and purged:
   a. Safety controls.
   b. Combustion safety and efficiency.
   c. Operational controls.
   d. Fuel and water leaks.
   e. Local code requirements.
6. The occupants shall be educated on the safe and efficient operation and maintenance of the new water heater, including the following procedures:
   a. Adjustment of water heater temperature.
   b. Periodic drain and flush.
   c. Expansion tank and backflow preventer (no occupant maintenance required).
   d. Periodic inspection.

10140 Water Heater Blankets

The installation of water heater blankets on gas-fired and electric water heaters in conditioned spaces is recommended unless this will void the water heater warranty. Gas water heaters should not be insulated.

10150 Water Heater Blanket Materials and Installation

1. The water heater insulation must have a protective covering to contain any insulation fibers.
2. An R-7 water heater blanket is preferred on all tanks not labeled with a prohibition to installing additional insulation to that already installed by the manufacturer.
3. A water heater blanket must be secured to the water heater with at least two (2) straps with buckles. The installed straps must not excessively compress the water heater blanket.
4. The water heater tank must be inspected to determine the type of water heater (gas, electric, etc.), and whenever possible, the amount of existing insulation.
5. If there are signs that the water heater is leaking, this problem must be solved before insulation is added.

6. Electric water heaters outside the occupiable space, including mobile home water heaters in exterior closets, must be insulated if the total existing tank insulation is less than R-7.
7. A water heater blanket must not be installed when a temperature and pressure relief valve does not exist or when the existing temperature and pressure relief does not operate properly.
8. A water heater insulation must not cover the following:
   a. The temperature and pressure relief valve on a gas-fired or electric unit.
   b. The drain valve on a gas-fired or electric unit.
   c. Where the electrical line attaches to an electric unit. Insulation must be keep at least two inches away from where this electrical line attaches to the water heater.
   d. The top of a gas-fired unit.
   e. The combustion supply air inlet on a gas-fired unit.

10160 Domestic Hot Water Temperature

1. Whenever feasible, the domestic hot water temperature must be measured and reduced to 120°F (measured at the faucet nearest the water heater) with the approval of the client/owner.
2. The client/owner must be informed that lowering the temperature of the water will result in less thermal energy stored in the hot water; therefore, they may run out of hot water sooner.
3. The original water temperature setting must be marked on the thermostatic control.

10170 Energy-Saving Showerheads

1. An energy-saving (low-flow) showerhead may be installed with client permission, if the replacement is possible and cost-effective and the installation does not require the use of a plumber.
2. The energy-saving showerhead must have a flow rating of 1.75 GPM or less. If multiple showerheads are provided for one shower unit, the total flow rate shall not exceed 3.5 GPM.
3. If an energy-saving showerhead is installed in conjunction with lowering the domestic hot water temperature, the chances are high that the client will not notice less hot water for showering, as they might if the temperature is reduced without installing the new showerhead.
4. Removed showerheads may be left with the client at their request.
5. The occupant's acceptance of a showerhead should be documented.

10180 Faucet Aerators

1. Measure aerator flow rate. Replace if rate is higher than 1.2 GPM.
2. Removed aerators may be left with the client at their request.
3. The occupant's acceptance of an aerator should be documented.

10200 Gas-Fired Cooking Ranges

Gas ranges shall be inspected, tested according to Section 13840 on page 124, and appropriate client education shall be delivered to an adult client in the household.

10300 Refrigerator Replacement and Metering

The refrigerator to be replaced must be the primary refrigerator used by the household. In cases where more than one refrigerator or freezer is being used, the agency should encourage the client to dispose of the secondary refrigerator or freezer by providing client education regarding the energy use of the unit(s). The disposal of a secondary refrigerator or freezer is an eligible activity; however, the client must provide the agency with written permission for this disposal.

10310 Refrigerator Replacement Policy

1. Refrigerator replacements must meet DOE requirements[15]; if applicable, the corresponding requirements of non-DOE funding, such as PNM, may be used.
2. The replacement refrigerator must be cost-effective. If the savings-to-investment ratio is less than one, no replacement is allowed. The savings-to-investment ratio must be documented in the client file. Agencies may combine electrical usage for the purpose of calculating cost-effectiveness when more than one refrigerator or freezer is disposed as part of the refrigerator replacement.
3. The client must give up possession of the old refrigerator.
4. All refrigerators that are replaced must be removed from the clients' premises upon delivery of the replacement and properly disposed of in accordance with The Clean Air Act, USC Title 42, Section 7671g. This Act makes it unlawful for any person to dispose of refrigerants in a manner in which they will be allowed to enter the atmosphere.
5. The replacement refrigerator must be an ENERGY STAR-rated with an estimated annual consumption of 600 kWh/yr or less. It must be a similar style and capacity as the one being replaced, with 17 to 18 cubic feet being average sized. Refrigerators with options such as an icemaker will not be considered allowable replacements.
6. The NEAT/MHEA audit tool can be used to calculate savings-to-investment ratio (SIR) and to provide documentation that the replacement SIR is greater than 1.0. NEAT can calculate the SIR of a refrigerator replacement in two ways:
   a. Built in Association of Home Appliance Manufacturers (AHAM) database of refrigerators.
   b. With the use of on-site metering data in units of kWh.[16] On-site metering is the preferred method of determining energy use, unless metering is not possible.
7. Age alone should not be the determining factor in replacing a refrigerator. Although older refrigerators were built to less efficient standards, other factors such as size and manual defrost impact energy use of existing refrigerators. However, any refrigerator older than 1993 may be a likely candidate for replacement. A refrigerator

[15] Please refer to "Incorporating Refrigerator Replacement into the Weatherization Assistance Program: Information Tool Kit", November 2001, by Alex Moore for more information. This document can be found at http://www.waptac.org/data/files/technical_tools/toolkit07.pdf.

[16] DOE requires at least 10 percent of replaced refrigerators to be metered.

10 years or older must be analyzed and considered for replacement either by obtaining the information from the AHAM databases or by on-site metering.

10320 Refrigerator Metering

1. Use a cumulative Watt-hour meter to determine the present usage of the refrigerator. Meter for at least two hours. The longer the metering time, the more accurate the projected annual kWh/yr estimate will be.
2. When metering, it is vital that the inspector determine with the metering instrument whether the refrigerator automatically defrosted during the metering time. If so, the metered values must be adjusted downward by eight percent. The NEAT/MHEA energy audits have check boxes to select if the defrost cycle is included in the metering.
3. Determine the average ambient temperature around the refrigerator during the metering and enter in the NEAT software ("Temperature ^{O}F").
4. Convert the Watt-hour reading on the meter to kilowatt hours (kWh) by dividing the Watt-hour reading by 1000. Enter the resulting value in the appropriate place in the NEAT software. For example, if the Watt-hour reading is 525, the kWh value entered in the NEAT software is 525/1000, or 0.525.
5. Enter the time period of the metering in the NEAT software. Make sure the time is in units of minutes.

10330 Ordering Replacement Refrigerators

1. The replacement should be of a similar style and capacity as the removed refrigerator. A larger capacity model than the removed unit may be considered if multiple refrigerators/freezers are being replaced.
2. WAP grant funds cannot be used to run water line for an icemaker.
3. Each agency is responsible for ordering appropriate ENERGY STAR® refrigerators either directly or by subcontracting.
4. Each agency is responsible for proper disposal of all refrigerators either directly or by subcontracting.

10340 Installation of Replacement Refrigerator

1. The replacement must fit into the existing refrigerator space and must have the hinges installed on the appropriate side. The installer should ensure that there is safe and adequate electrical supply, the floor is structurally adequate to properly support the new unit, and the doors and hallways of the home are sufficient to allow removal of the old refrigerator and installation of the new one.

10400 *Compact Fluorescent Bulbs*

10410 Introduction

Many new compact fluorescent lamps (CFLs) meet the stringent criteria of Energy Star® for long life, start time, energy savings, color, and brightness. These new CFLs provide high quality, warm light without the flickering or humming of older fluorescent bulbs.

Advanced technology enables CFLs to use up to 75 percent less energy than a standard incandescent bulb and last up to 10 times longer. This means that over the life of one CFL, a client can avoid replacing up to 13 incandescent bulbs.

10420 Replacement Procedure

1. All replacement CFLs must be Energy Star® rated.
2. Discuss the lighting schedule with the client. Focus on incandescent lamps that are on for one or more hours each day.
   a. Educate the client about incandescent lamp use, including using these lamps as little as possible
   b. Ask the client, after your client education efforts, which incandescent lamps are likely to be on for one or more hours each day. Replace these incandescent lamps with compact fluorescent lamps (CFLs).
3. Ensure that replacement CFLs are the appropriate type for replacing outdoor or lamps/fixtures with dimmers.
4. Any replacement CFLs should have a lumen rating (light output) very close to the replaced incandescent lamp. If the Watt use of typical CFLs and incandescent lamps are matched according to Table 10-1, the lumens output will be approximately the same.

Table 10-1

CFL/Incandescent Lamp Equivalency Chart	
CFL, Watts	**Incandescent, Watts**
9 – 13	40
13 – 15	60
18 – 25	75
23 – 30	100
30 – 52	150

5. Replacement CFLs should be rated 2700 to 3000 Kelvin. This color index is similar to incandescent bulbs.

11000 Multifamily Building Weatherization

For energy auditing purposes, DOE considers multifamily buildings to be those containing five dwelling units or more. Approved single-family energy audits, such as NEAT, may be used in buildings with one to four dwelling units. NEAT may be used on some multifamily buildings up to 25 *individually* heated/cooled dwelling units with approval from DOE on a case-by-case basis.

For small multifamily buildings of 25 or fewer dwelling units containing central heating/cooling systems, NEAT may not be used. In the past DOE has reviewed and accepted the use of EA-Quip and TREAT as permissible energy audits.

For larger multifamily buildings greater than 25 dwelling units, NEAT may not be used. In the past DOE has reviewed and accepted the use of EA-Quip and TREAT as permissible energy audits.

The energy-saving options in for small multifamily buildings are similar to those for single-family buildings. However, larger multifamily buildings require a different approach and the energy-saving options differ. Instead of having an energy auditor perform the inspection and decide on the measures, larger multifamily buildings are often inspected by a team of experts, including the energy auditor. Additionally, procedural details such as the following must be worked out at the beginning of a project:

1. Who is the client, the tenant or the owner?
2. Who must apply for weatherization services?
3. Who pays for the utilities, the owner or the tenant?
4. Is there a building manager?
5. Who will decide what measures are implemented?

Some of the possible energy-saving options for larger multifamily buildings include the following:

1. The heating systems usually are boilers and serve many units.
    a. Balancing and insulating distribution.
    b. System controls, such as outdoor reset, in-unit temperature controls, and cycle control.
    c. Install modular system.
2. Domestic hot water systems.
    a. Water temperature.
    b. Install low-flow showerheads and faucet aerators.
    c. Insulate distribution pipes.
    d. Separate domestic hot water from space heating.
    e. Install storage tanks for tankless coils.
3. Envelope treatment.
    a. Air seal and insulate attic.
    b. Often difficult to insulate walls if masonry.
    c. Repair broken glass, seal holes in walls, and re-point masonry.

d. Treat air conditioner sleeves.
e. Reduce stack effect within building by sealing vertical shafts and chases.

4. Mechanical ventilation should be analyzed for effectiveness and savings.
   a. Follow ASHRAE 62.2-2010 standard.
   b. Does the system work? Are the units and common areas over or under ventilated? Do the controls work?
   c. Clean and balance system(s).
   d. Measure flow rates.
5. Baseload
   a. Replace refrigerators.
   b. Indoor and outdoor lighting change out and controls.

12000 Renewable Technologies

[Content for this chapter will be added at a later date]

13000 Diagnostic Testing Procedures

13100 Blower Door Testing

The use of a blower door as a weatherization tool is mandatory. It can be used to determine the pre- and post-weatherization dwelling leakage rates, giving the crew or contractor an accurate idea of the effectiveness of air sealing efforts. In addition, the blower door is used for zone pressure testing and duct leakage testing.

Because the blower door is such an important weatherization tool, it is very important that it be set up and used properly at each weatherization job. The depressurization blower door test is preferred for New Mexico Energy$mart Program because it takes less time to perform than a pressurization test, and it is the standard test used in the low-income weatherization program across the United States.

The blower door testing procedures below are generalized to include the equipment sold by the Energy Conservatory and Retrotec. Please refer to the manufacturer's instructions for more detailed information.

Refer to Section 42000 on page 41 for examples when a blower door test might not be required.

13110 Preparation for Blower Door Test

1. Agencies and contractors should maintain accurate calibration of their blower doors and related equipment. This includes:
   a. Blower door fan.
      i. There should be no physical damage to the fan.
      ii. The flow sensor is one of the most critical parts of the blower door fan. Make sure the sensor is in its proper position, not damaged, that the connected hose is in good condition, and that the holes in the sensor are not blocked.
   b. If there is a problem with the fan or the flow sensor, contact the manufacturer before further use.
   c. Digital pressure gauges must be calibrated as recommended by the manufacturer.
   d. For detailed maintenance recommendations check with the equipment manufacturer.
2. Deactivate all vented combustion appliances before depressurizing the structure by turning the thermostat down, or by shutting the appliance off. A gas water heater may be set on "Pilot" rather than setting the control on "Off".
3. Prevent the ashes of wood- or coal-burning units from entering the habitable space by closing and sealing doors and dampers, by cleaning out the ashes, or covering them.

4. Inspect the house for loose or missing hatchways, paneling, ceiling tiles, or glazing panes. Secure any items that may become dislocated during the test and seal any missing hatchways.
5. Close all primary windows, self-storing storm windows (if possible), skylights, and exterior doors and latch them in the position they normally would be found during the winter.
6. Open all livable areas to the interior of the structure, even if the occupants close them off during the winter.
7. If the basement is defined as an area within the thermal envelope, determine the CFM_{50} value with the blower door with the basement door opened.
8. Set up the blower door unit in an exterior door opening in an area free from obstructions and wind interference.

13120 Blower Door Test, Depressurization (typical)

1. Set up the blower door in an exterior door that has the least number of obstacles within three feet of the blower door fan. If the doorway leads to an enclosed area, make sure the space is open to the outdoors. Do not set up in a door facing the wind if an acceptable alternative exists.
2. Install the frame and panel securely into the doorframe, making sure there are no gaps between any of the components or between the components and the doorframe.
3. Set the fan into the panel/frame assembly, making sure that the panel opening fits snugly around the fan. Install the fan so that the flow ring assembly (or low flow plate) is facing toward the inside of the house. Set up the fan in a level, or nearly level, position.
4. Set up the digital manometer in a vertical position.
5. Make sure the blower door variable speed control is in the off position. Plug the fan electric cord into a safe and fully functional electrical outlet.
6. Attach the hoses properly to the digital gauge and blower door.
7. Perform a one-point test by depressurizing to -50 Pascals house pressure or, if unable to reach -50 Pascals, the highest possible house pressure possible. Use one of the flow rings if the fan pressure is too low (your digital manometer will indicate if the fan is running too slowly to reach a proper fan pressure). If wind seems to be affecting the test results, take several one-point tests and average the results.
8. Determine the CFM_{50} value with the digital manometer.

13130 Blower Door Test, Pressurization

1. Use the pressurization blower door test only if a solid fuel heating unit or a drip-pot, oil-burning space heater is in operation, or for some other reason, it is approved by the New Mexico MFA.
   a. Generally a pressurization test is not done because it is more difficult, primarily because the flow rings/range plates must be positioned on the outdoors.
2. Install the door panel as it is normally.

3. Install the fan with the flow rings/low-flow plate facing the outdoors. The fan hose and the extra hose will run outside between the fan housing and the elastic collar. The fan speed control must remain on the indoor side.
4. Level and stabilize the fan as necessary.
5. Do not change the fan directional switch from its normal (forward) position.
6. Attach the hoses properly to the digital gauge and blower door.
7. Perform a one-point test by pressurizing to 50 Pascals house pressure or, if unable to reach 50 Pascals, the highest possible house pressure possible. Use one of the flow rings if the fan pressure is too low (your digital manometer will indicate if the fan is running too slowly to reach a proper fan pressure). If wind seems to be affecting the test results, take several one-point tests and average the results.
8. Determine the CFM_{50} value with the digital manometer.

13200 *Air Sealing Target (AST) and Air Sealing Limit (ASL)*

MFA recognizes that cost-effective air sealing procedures with the incremental use of a blower door and computer software are the best way to determine when to continue and when to stop air sealing a dwelling. MFA recommends this method.

When this method is not used, the crew or subcontractor performing the air sealing work should tighten to the dwelling Air Sealing Target (AST) CFM_{50} or lower. The AST is determined by dividing the *above-grade* volume within the thermal/pressure envelope by 10. For example, if the volume of the above-grade thermal/pressure envelope is 12,000 ft^3, the AST is 1200 CFM_{50}. Refer to Section 5200 on page 44 for more information.

The lowest AST shall be 1000 CFM_{50}.

The CFM_{50} used for this procedure shall correspond with the standard method of determining the blower door test volume. That is, if a basement or crawl space is defined as being within the thermal/pressure envelope, for the pre- and post-weatherization blower door tests, as well as those done during air sealing; the basement or crawlspace should be open to the main part of the dwelling.[17]

The Air Sealing Limit (ASL) shall be the higher of the following:

1. Air Sealing Target (AST) CFM_{50}.
2. The Depressurization Tightness Limit CFM_{50}. The DTL CFM_{50} value shall be based on the post-weatherization condition of the dwelling (exhaust appliances and vented combustion appliances). Refer to Section 13300 on page 116 for calculation details.

If the dwelling ends up tighter than the Air Sealing Limit (ASL), ensure the following:

[17] For example, if the above grade house volume is 12,000 ft^3, which includes a basement with an average height of two feet above grade, the AST is 1200 CFM_{50}. This volume measurement should not include the part of the basement that is below grade. When performing blower door testing in an attempt to air seal to this 1200 CFM_{50} AST, the basement door should be open. This open basement door includes the above- and below-grade volume of the basement. On the other hand, if the basement is not considered a part of the thermal/pressure envelope, none of its volume would be included in the determination of the AST and the basement door would be closed during any blower door testing.

1. All combustion appliances are drafting properly and not spilling (see Section 13800 on page 123 for worst-case depressurization testing details); and
2. Minimum ventilation for acceptable indoor air quality is installed in accordance with ASHRAE 62.2-2010. See Section 41500 on page 34 for details.

13300 Depressurization Tightness Limit (DTL)

13310 Introduction

If the dwelling has conventionally vented (open) combustion appliances, the Depressurization Tightness Limit (DTL) should be calculated before weatherization work begins.

The DTL calculation establishes a CFM_{50} minimum, below which the backdrafting of conventionally vented combustion appliances is likely to occur. This limit provides a guideline for air sealing activities.

If the energy auditor expects exhaust fans will be added to the dwelling in order to comply with ASHRAE 62.2-2010, an estimate of the CFM fan flow of these added fans should be included in this procedure.

The use of the DTL should never be used as a substitute for performing the worst-case depressurization test procedure after all weatherization work is completed.

13320 DTL Procedure

1. Use Chart 13-3 to find the DTL CFM_{50} value for the dwelling DTL.
   a. Enter the total CFM exhaust rate for all the exhausting appliances in the dwelling. It is always better to measure the exhaust rate of existing fans if possible, rather than estimate the rate. Include any appliances that are not yet installed but will be during your weatherization work. For example, include the CFM exhaust rate of an electric or gas dryer that is not vented to the outdoors now, but will be vented as part of your work. Refer Table 13-1 for guidance.

Table 13-1

Exhaust Appliance Nominal CFM	
Appliance	***CFM Nominal***
Bathroom exhaust fan	50
Kitchen range hood	100
Kitchen wall fan	250
Kitchen down-vent fan (Jenn-Air)	300 - 600
Dryer	180
Central vacuum	150
Fireplace	200 - 400
Note: Actual CFM might be significantly less than nominal - or rated - CFM.	

b. Select and enter the appropriate building depressurization limit based on Table 13-2. If more than one appliance is located in a combustion appliance zone (CAZ), use the appliance Pascal limit most likely to backdraft. For example, an appliance with a rating of -2 Pascals is more likely to backdraft than an appliance rated at -5 Pascals.

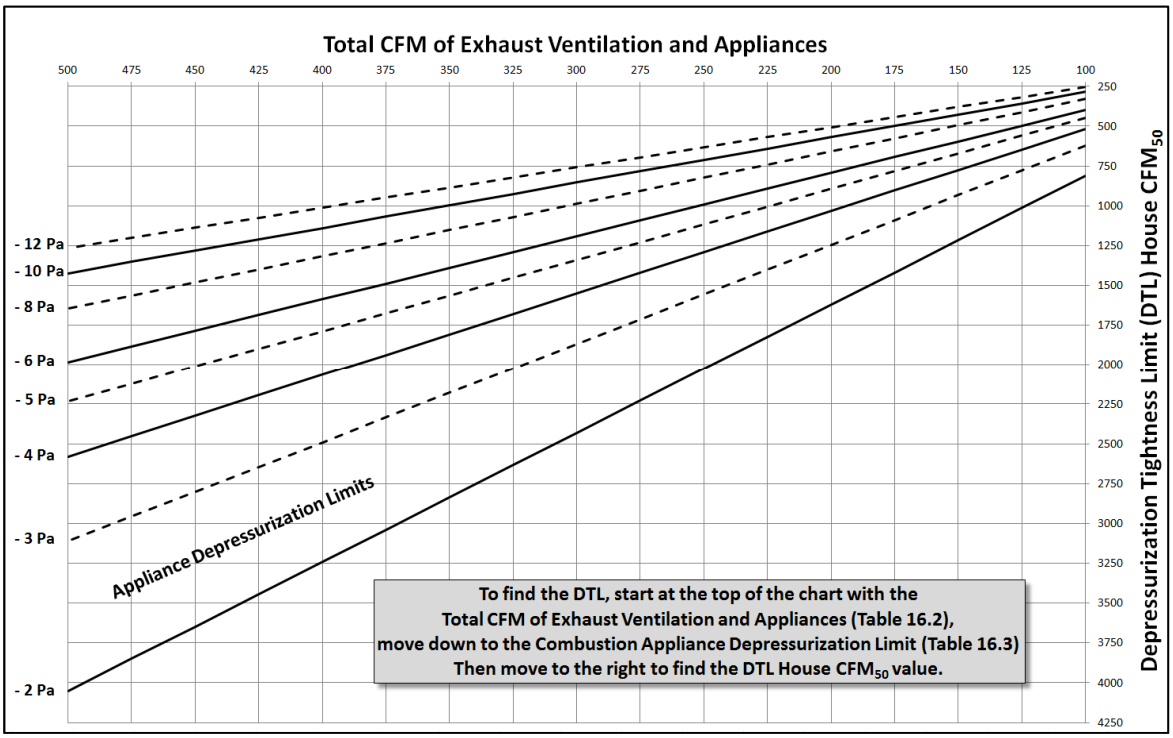
Table 13-2

Combustion Appliance Depressurization Limits	
Appliance Type	***Maximum Depressurization Limit, Pascals***
Appliances with manufacturer certified negative pressure tolerance rating	The manufacturer- certified negative pressure tolerance rating
Atmospheric water heater not common vented (Category I, natural draft), open-combustion appliances	-2
Atmospheric water heater (Category I, natural draft) common vented with atmospheric furnace (Category I, natural draft or Category I, fan assisted), open-combustion appliances	-3
Gas furnace or boiler, Category I or Category I fan-assisted, open-combustion appliances	-5
Oil or gas unit with power burner, low- or high-static pressure burner, open combustion appliances	-5
Closed, controlled wood-burning appliances	-7
Induced-draft appliances (fan at point of exit at wall), Category I with induced draft, open-combustion appliances	-15
Pellet stoves with exhaust fans and sealed vents	-15
Gas appliances, Category III or Category IV, vented through the wall, forced draft, open-combustion appliances	-15
Direct-vent, sealed combustion appliances with forced draft	-25
Adapted from Minnesota Energy Code 7672.0900 and Canadian General Standards Board 51.71.	

2. Determine the CFM_{50} Depressurization Tightness Limit for combustion safety. Use this as a low limit to house tightening. For example, if the DTL is 1600 CFM_{50}, instruct the crew or contractor not to tighten to below 1600 CMF_{50}. Refer to Section 13200 on page 115 for more information regarding the Air Sealing Target and the Air Sealing Limit.

Remember, the DTL is a pre-weatherization guideline only; it must never be used to replace real-time combustion safety testing.

Chart 13-3



13400 Air Handler Pressure Balance Testing

13410 Introduction

This test procedure is performed only in dwellings with central air handlers (furnaces and/or central air conditioners). Room-to-room pressure(s) should be measured in all rooms with forced air heating/cooling return or supply ducts and operable interior doors, *after all weatherization work has been completed, but before the final combustion safety testing is performed*. The procedure indicates the magnitude of the following issues:

1. Duct leakage to the outdoors, either through supply or return ducts.
2. Imbalances of air distribution resulting from closed interior doors. These closed doors can act as dampers to the free flow of air within the conditioned space of the dwelling.
3. Imbalances of air distribution resulting from airflow differences between the supply side and return side of the ductwork. Such an imbalance could result from a restricted return trunk, for example.
4. Such pressure imbalances can result in increased air leakage to and from the outdoors when the air handler is running.

13420 Whole House Test Procedure

1. Set up the house in winter operating mode.

2. Using a digital manometer, run a pressure hose from the main body of the house to the outdoors.
3. Record any pressure difference between the main body of the dwelling and the outdoors. This is the reference baseline pressure.
    a. A reference baseline pressure is generally due to stack-effect air leakage (especially if it is cold outdoors) or wind.
4. Turn on the air handler and measure the pressure of the main body of the house with reference to the outdoors.
    a. If the pressure difference between the main body and the outdoors is different with the air handler on than with the air handler off, there is probably some duct leakage to the outdoors from one of two sources:
        i. From the return side of the system (the pressure difference of the dwelling with reference to outdoors will move toward positive when the air handler is activated).
        ii. From the supply side of the system (the pressure difference of the dwelling with reference to outdoors will move toward negative when the air handler is activated).
5. Close all interior doors.
6. Repeat the pressure measurement from the main body of the house with reference to the outdoors.
    a. If this pressure is different than it was when all the interior doors were open, the interior doors are acting as dampers to the air distribution system. This can cause thermal discomfort and stuffiness in the room and it can increase the air leakage to and from the outdoors when the air handler is running.

13430 Room-to-Room Test Procedure

1. With a digital manometer measure the pressure difference across all interior doors. Record measurements for all rooms with reference to the main body of the house. Make sure that registers and grilles are not blocked, even though they appear open. Provide pressure relief to any room with readings greater than three Pascals with these steps:
    a. Opening the door slightly while measuring the pressure difference across the door. Open the door until the pressure difference is less than three Pascals and measure the square inches of the opening. This is the number of square inches for the following dimensions:
        i. By which the door must be undercut (this usually works well in mobile homes).
        ii. Of the cross sectional area of a direct grille, offset grille, or jump duct that must be installed to properly relieve the pressure imbalance caused by the distribution system when the door is closed.
2. Turn off the air handler and return the house to the condition it was in before testing began.

13500 Furnace Temperature Rise Measurement

Excessive heat rise can result from low air handler fan output (wrong fan speed, bad motor bearings, low voltage, dirty blower, wrong fan rotation, slipping or broken fan belt); low airflow

from restrictions in ductwork; or an over-fired burner. Low heat rise can result from excessive fan speed, excessive duct leakage, or an under-fired burner.

The temperature rise should be within the range specified on the manufacturer's label, or between 40° and 80° F.

Look for the appropriate manufacturer's heat rise on the name-plate of the unit.

1. *Up-flow furnaces* (these are typically found in basements or closets):
   a. *Supply side:* Drill a hole and insert the thermometer in the supply plenum as close as possible to the heat exchanger, but "out of sight" of the heat exchanger (this ensures that the reading will not be affected by radiant thermal energy from the heat exchanger). It is preferred to drill a test hole near each of the four corners of the supply plenum, check the supply-air temperature in each, and average these readings for use as the supply temperature. If the furnace plenum houses a central air conditioning coil, be very careful to avoid damaging this coil. Drill the hole beyond the cooling coil.
   b. *Return side:* Drill a hole and insert the thermometer into the return plenum approximately two feet before the filter. Where an integral humidifier with a crossover duct is present, drill the hole before the crossover duct from the supply plenum so that the temperature is not affected by the warmer air in the crossover duct.
2. *Horizontal-flow furnaces* (these are typically found in crawl spaces or attics):
   a. Drill a hole and insert the thermometer in the supply plenum as close as possible to the heat exchanger, but "out of sight" of the heat exchanger (this ensures that the reading will not be affected by radiant thermal energy from the heat exchanger). If access is available, it is preferred to drill a test hole near each of the four corners of the supply plenum, check the supply-air temperature in each, and average these readings for use as the supply temperature.
   b. *Return side:* Drill a hole and insert the thermometer into the return plenum approximately two feet before the filter.
3. *Down-flow furnaces* (these are typically found in mobile homes). The furnace compartment door should be closed while taking the temperature readings. The instructions below assume a living space return system, rather than a belly return system.
   a. Inspect and, if necessary, repair the plenum/furnace joint before measuring the temperature rise.
   b. Make sure all interior doors are open, including the furnace closet door.
      i. The furnace closet door should be a louvered door.
   c. Turn on the furnace and allow the temperature of the supply air to stabilize. Measure the temperature at the register closest to the furnace – supply air temperature – making sure that the airflow to this register is not blocked and that there is no significant duct leakage between the furnace and your thermometer.
   d. Subtract the return air temperature from the supply air temperature. The difference is the temperature rise.
      i. Test the return side air temperature by placing the thermometer probe at or through the slots in the blower compartment cover near the top of the furnace.

e. If the temperature rise is greater than the recommended range, the airflow is probably being restricted by either:
   i. An undersized opening in the furnace closet door, or
   ii. Undetected restriction in the ductwork.
f. If the temperature rise is less than the recommended range, there might be either:
   i. Significant leakage at the furnace/plenum joint, or
   ii. Significant leakage in the duct between the furnace and the location of your supply air temperature measurement.
g. If the temperature rise is out of range, repair the cause of the problem by removing any restriction to airflow or repairing leaks. Check the temperature rise again.

4. Patch all test holes with an appropriate material.

13600 *External Static Pressure Testing*

This test helps determine problems with the ductwork and/or the distribution fan.

If the external static pressure (ESP) is too high, the airflow might be blocked or the ductwork might be too small or restricted. The higher the ESP, the lower the airflow within the ductwork. If the ESP is too low, the ductwork might be very leaky or the blower might be dirty or working improperly.

Typical ESP values are from 0.5 IWC or 125 Pascals with a coil and filter and 0.25 IWC or 62 Pascals without a coil and filter.

1. Find the manufacturer's recommended external static pressure value on the name-plate of the unit. It is likely that this value will be in units of Inches of Water Column, rather than Pascals. Record this recommended value (it is the combined values of the supply-side and return-side static pressures, ignoring the negative sign of the return-side static pressure).
2. Make sure the furnace filter is in place. A clean filter is preferred.
3. With a static pressure tip connected to your digital manometer, measure both the supply- and return-side static pressure at the outlet and inlet of the blower by drilling measurement holes in the supply and return ductwork.
   a. In order to avoid turbulence, take readings three to five duct diameters downstream of the air handler blower.
   b. Do not measure air conditioning coil unless it shipped with unit. On some jobs, this will be difficult to determine. In all cases, document whether you measured the static pressure of the air conditioning coil or not.
      i. To measure the air conditioning coil static pressure, the hole for the static pressure tip connected to your digital manometer must be located downstream (after) of the air conditioning coil. Take care that the coil is not damaged by your activities.
      ii. To ensure that you are not measuring the static pressure of the air conditioning coil, locate the test hole upstream (before) the air conditioning coil. Take care that the coil is not damaged by your activities.

4. Add the supply- and return-side static pressures together—ignoring the negative sign of the return side pressure—to find the total external static pressure.
   a. This total ESP should fall within the range of the manufacturer's recommendations on the appliance label. If it does not, correct the problem and retest.
   b. It is preferred that the supply- and return-side static pressure values are of similar magnitudes. Restricted returns, usually undersized, are a common problem with ducted distribution systems. The energy auditor or heating system technician must determine if a restricted return should be repaired or not.
5. Patch all test holes with an appropriate material.

13700 Duct Leakage Testing

13710 Introduction

Duct leakage can lead to many problems in a dwelling, the most common one being wasted energy. Other problems can include thermal discomfort, substandard indoor air quality, and combustion venting failure.

Ductwork leakage can take place 1) within the confines of the conditioned envelope of the building or 2) to and from the outdoors.

Leakage to or from the outdoors wastes more energy than leakage within the confines of the thermal envelope. Mobile home ducts and site built homes with ductwork in crawl spaces or attics are susceptible to leakage to and from the outdoors.

On the other hand, although duct leakage within the conditioned envelope usually does not have a significant energy impact, it might impose a hazard to occupant health by causing poor indoor air quality or backdrafting of combustion appliances. These potential problems are addressed on site by an IAQ appraisal and by performing the worst-case depressurization testing.

13720 Pressure Pan Testing in Mobile Homes and Site-Built Dwellings with Ductwork Outside of the Thermal/Pressure Envelope

1. Install the blower door for a depressurization test. Make sure the dwelling is set up for winter conditions.
2. Open all interior doors.
3. Make sure the furnace burner and air handler are off and will not start during the testing.
4. Remove the filter(s) from the duct system for the pressure pan test.
5. Temporarily seal outside combustion air inlets or ventilation system connections that are directly connected to the duct system. These connections will show up as large leaks if not sealed prior to testing.
6. Open spaces outside of the thermal/pressure envelope containing ductwork to the outdoors as much as possible. The ideal is to have a pressure of 50 Pascals from

the house to these spaces. If the measured pressure is below 45 Pascals, re-check to be sure all operable vents and other openings are fully open.

a. Open skirting under the mobile home to the outdoor air.
b. Open a site-build home crawlspace of basement to the outdoors.
c. In attic spaces containing ductwork, open the attic as much as possible to the outdoors for the test.

7. Only one person at a time should be taking pressure pan readings. Having two registers in different parts of the duct covered by a pressure pan at the same time might affect readings.
8. Depressurize the dwelling to -50 Pascals with the blower door.
9. Make sure the pressure pan is properly connected to the manometer. The proper connection should be reading the space under the pressure pan with reference to the main dwelling pressure.
10. Place the pressure pan completely over each register and grille in conditioned areas.
    a. If a register or grille is larger than the pressure pan, cover the oversized portion of the register or grille with tape while the reading is recorded.
    b. If access to a register or grille is difficult, for example at a kitchen counter kick space, cover the entire opening with tape and insert the pressure probe through the tape (near the center of the taped opening) while the reading is recorded.
    c. When two registers or grilles are closely connected to the same duct run (for example, two registers on opposite sides of the same partition wall), seal one and use the pressure pan on the other unsealed register or grille. Once you have taken the pressure pan reading, remove the seal before proceeding to the next register.
11. Record the pressure pan readings before and after duct sealing activities to get an idea of the effectiveness of the sealing. It will sometimes be useful to record readings during duct sealing. Always start your measurements using the blower door as a reference point and work clockwise around the dwelling.
12. If you are testing a dwelling with a very leaky building shell and are not able to create a 50 Pa pressure difference with the blower door, perform your pressure pan tests with the dwelling at the highest achievable pressure. In this case, you will need to interpret your pressure pan readings carefully. Compare the measured pressure pan reading with the maximum possible reading.
13. Record the pre- and post-weatherization in the client file.

13800 Combustion Safety Testing

13810 Introduction

The purpose of combustion safety testing is to ensure the health and safety of the occupants. Combustion safety testing includes the following critical inspections and tests:

1. Measuring ambient CO concentrations throughout dwelling, but especially in the vicinity of combustion appliances.
2. Gas leak testing and fuel oil leak inspection.
3. Inspection and CO emissions testing of gas ovens.

4. Worst-case combustion appliance zone (CAZ) depressurization.
   a. Under worst-case depressurization conditions, test vented Category I combustion appliances for:
      i. Spillage.
      ii. Adequate draft.
      iii. Carbon monoxide emissions within the vent system. These measurements shall always be taken in combustion gases before dilution are enters the vent system.

The importance of these tests cannot be overemphasized. If for any reason these tests cannot be performed, the reason(s) must be documented in the client file.

13820 Measure Ambient Carbon Monoxide.

1. Upon entering the dwelling, the energy auditor shall have their CO measurement instrument running in order to measure ambient concentrations of carbon monoxide.
2. If CO is detected at levels greater than nine ppm, determine the source and correct the problem before proceeding.

13830 Gas Leak Testing

1. Combustible gas leak testing shall be done on all accessible natural gas and propane piping including where pipes connect to appliances.
   a. Inspect fittings and joints with an electronic combustible gas detector. Make sure to move the detector slowly along the gas line—above the line for natural gas and below the line for propane.
   b. Verify any found leaks with a non-corrosive leak detection fluid.
2. All leaks must be repaired.

13840 Fuel Oil Leak Inspection

1. Check the oil supply line from the oil tank to the heating unit for any evidence of leaks. Pay close attention to the fuel oil line as it exists the oil storage tank, at any line connections, and around the oil filter.
2. Any fuel oil leaks must be repaired.

13850 Inspection, Testing and Adjustment of Gas-Fired Ranges

1. Check for CO in ambient air upon arrival. If greater than nine ppm, determine the source and correct the problem before proceeding.
2. Inspect the gas range installation for code compliance. Refer to the latest edition of the National Fuel Gas Code (NFPA 54), Household Cooking Appliances.
3. Check for gas leaks. If leaks are found, repair and document them before proceeding.

4. Check the flexible range connector for the date ring. If the connector doesn't have a date ring and/or is brass, replace the connector. The connector must connect outside of the cabinet and must pass through the wall of the range cabinet.
5. For the range top burners:
   a. Check for missing or broken grates over burners. Replace if necessary.
   b. Turn on each burner to check for the problems of high noise level or predominantly yellow flame (yellow specks are not a problem; this is dust being burned in the flame). Repair if necessary.
6. For the oven bake burner (do not test a separate broil burner):
   a. Remove cooking utensils from oven. Make sure foil or other materials are not obstructing the holes in the oven floor.
   b. Turn on burner to the maximum temperature, but not to "broil".
   c. Insert the probe into the oven vent far enough to get an undiluted exhaust gas sample.
   d. The CO emissions increase and then peak just after burner start up; they then fall to a momentary plateau before the burner shuts down as part of the duty cycle. The reading CO ppm must be taken during this stable plateau. Record this "plateau" reading in the client file.
   e. If the reading is above 100 ppm as-measured or 800 ppm air-free, then do the following:
      i. Clean any rust and soot buildup on the spreader plate caused by flame impingement.
      ii. Clean the burner if needed.
      iii. Check for obstructed secondary air. If it is obstructed, remove the obstruction and educate the client how to keep from obstructing the burner.
      iv. Check the primary air adjustment and adjust if necessary or clear away any restrictions.
      v. Check to see that the burner is in alignment; it may require leveling the entire appliance.
      vi. Check the orifice size to ensure they are the right type and size in regard to LPG or natural gas. If the orifices need to be changed or adjusted, do so with the burner and the pilot orifices.
7. With a manometer (water column gauge), check that the gas pressure is correct. If the pressure regulator requires replacement, do so.

13860 Worst-Case CAZ Depressurization Testing

The purpose of worst-case depressurization testing is to ensure the proper venting of all vented combustion devices in a dwelling. This testing must always be done before and after all other weatherization work has been completed. It is recommended that testing be completed at the end of every workday before the workers leave the site. This intermittent testing should be conducted by the supervisor at the weatherization site.

The test results or any reason for not conducting the test must be documented in the client file.

The Depressurization Tightness Limit (DTL) should also be calculated before weatherization work begins when conditions warrant. The DTL is a CFM_{50} estimate that is used as an air sealing guideline. If the dwelling is tightened to a CFM_{50} value that is less than the DTL, backdrafting is likely to occur. The DTL must never be used as a substitute for worst-case depressurization testing. Please see Section 13300 on page 116 for more information regarding the DTL.

The worst-case depressurization test measures the pressure difference between the outside and inside of the house at the combustion appliances in the combustion appliance zone (CAZ). This measurement will confirm whether there is adequate draft for the vent system of all conventionally vented combustion appliances. If a house contains more than one CAZ, a worst-case depressurization test must be performed for each area.

13861 Dwellings Requiring Worst-Case Depressurization Testing

Worst-case depressurization testing must be done in all dwellings before and after all other work has been completed in all units that were weatherized.

The following are *exceptions* to this requirement:

1. If the house or mobile home is all-electric with no combustion appliances, woodstoves or fireplaces, or has appliances that are all sealed combustion (direct vent) or unvented (vent free), a worst-case depressurization test does not have to be performed.
2. In apartments with no combustion appliances other than unvented or direct-vent combustion appliances, a worst-case depressurization test does not have to be performed.

13862 Test Procedure

"Worst-case" is defined as the configuration of the house that results in the greatest negative pressure *in the combustion appliance zone* (CAZ). Consideration must be given to the following conditions:

1. The types and locations of the heating systems.
2. The location and CFM rating of all exhausting equipment (bath fans, dryers, kitchen exhaust devices, etc.).
3. The location of wood stoves, fireplaces, and water heaters.
4. The volume of the area where the combustion devices are located.
5. The location of forced-air system returns.

13863 Procedure Setup

1. Place the building in the blower-door-test condition with all windows and exterior doors closed. If it is not practical to close or install existing storm windows, latch or lock primary window units. If the blower door is set up,

make sure the fan is closed off. Position all interior doors as you would for a blower door test.

   a. Be aware that wind will cause the pressure readings to fluctuate. During windy conditions, it will reduce pressure reading fluctuations if the pressure time average setting on the digital manometer is lengthened.

2. Record the outdoor temperature on the Worst-Case Depressurization Test form for this test. Other information should also be recorded on this form during the test procedure.
3. Deactivate all combustion appliances by turning them off or setting the control to "pilot."
4. Close all operable vents (for example, a fireplace damper).
5. If there is a furnace, replace or clean a dirty filter.
6. Check and clean the lint filter in the dryer.
7. Set up pressure hoses so that the pressure differential of the CAZ with reference to the outdoors can be easily measured with a digital manometer. If the CAZ is in a basement, run a pressure hose to the outdoors through a window or door, and then close the window or door as tightly as possible without totally closing off airflow through the hose.
8. With the interior doors in the conditioned area open and all combustion appliances and exhaust devices off, record the baseline pressure in the CAZ. This is the pressure in the CAZ resulting from stack-effect air leakage. Generally, the colder the outdoor temperature, the greater the magnitude of this baseline value. Record the baseline pressure on the Worst-Case Depressurization form.
   a. The baseline pressure should be taken with the CAZ door in the same position used for the blower door test.

13864 Determining Worst-Case Conditions

1. Turn on all exhaust devices (except a whole-house exhaust fan) and record the pressure in the CAZ. The pressure created in the CAZ from the operation of these exhaust fans is the difference between this value and the baseline pressure measured in step eight above.

Note: If there is a whole-house exhaust fan, it is important to inform the client that operating this fan with the house closed up could be very hazardous.

2. If the house contains a furnace/central air conditioner, activate the blower to determine if/how much the furnace contributes to depressurization/pressurization. Record the pressure reading in the CAZ with reference to the outdoors. If the furnace/air conditioner blower makes the CAZ pressure more positive, turn it off for the remainder of the testing. If its operation contributes to a greater negative pressure in the CAZ, leave it running for the remainder of the testing.

Caution: If the only way to activate the blower is to fire the furnace, extreme caution must be used due to the potential for combustion backdrafting or

flame rollout. Try to activate the furnace blower without firing the furnace burner.

3. Close each interior door and measure the pressure difference between the main body of the house and the room you are closing off when standing on the main-body side of the door with your digital pressure gauge. If the pressure in the closed room is negative relative to the main body of the house, leave this door open. If this pressure is positive, close this door.

Note: Room-to-room pressure testing and adjusting should have been completed before this worst-case depressurization test is performed. Refer to Section 13400 on page 118 for this test.

b. For this step, there are some underlying assumptions:

i The main body of the house is connected to the CAZ being tested.

ii If the house has a ducted distribution system, the air handler blower is operating.

iii All exhaust appliances in the house, except a whole-house fan, are running.

4. Close the door to the CAZ. If closing this door results in greater depressurization in the CAZ with reference to the outdoors (so that, for example, closing the door changes the pressure from -2 to -4), leave this door closed. If closing this door decreases the depressurization (so that, for example, closing the door changes the pressure from -4 to -3), leave this door open.

5. Record the net worst-case depressurization; that is, the negative pressure of greatest magnitude in the CAZ with reference to outdoors after subtracting the baseline CAZ pressure.

13865 *Worst-Case Depressurization vs. Appliance Depressurization Limit*

1. Compare the net worst-case depressurization with the appliance depressurization limits in Table 13-2. If the actual net worst-case depressurization is equal to or more negative than the appliance depressurization limit value in Table 13-2.

a. Implement measures to rectify this hazardous condition by selecting the appropriate option in Section 13866, number 6.

13866 *Verifying Proper Appliance Venting*

1. NOTE: During this testing under worst-case depressurization, the analyst shall continuously monitor ambient CO concentrations. If concentrations rise to a level of 35 ppm, the testing shall be stopped and the area purged with fresh outdoor air. Before testing continues, the source of this CO must be mitigated.

2. Under these worst-case conditions, fire the combustion appliance with the lowest Btu input first. Check for spillage after one minute of firing. If the appliance spills after one minute, it fails the spillage test.
3. When the appliance reaches steady-state conditions (stable temperature in the vent connector), measure the draft at the appropriate location. The draft should comply with the draft values in Table 13-4 or 13-5. If the draft is weaker than the values in Table 13-4 or 13-5, the appliance fails the draft test.
4. After the appliance reaches steady state (stable temperature in the vent connector), measure the CO in the vent connector of the appliance, ensuring that there is no room dilution air at the point of measurement. The CO value must be less than 200 ppm as-measured or 400 ppm air-free.
    a. If the CO levels are higher, the appliance must be cleaned and tuned and then retested for CO.
5. Fire all remaining appliances, one at a time, in order of input rating (smaller to larger), testing each one for spillage and draft. All appliances must achieve acceptable spillage and draft tests.
    a. If the appliances vent into the same chimney flue or vent connector, test each one individually.
    b. If the appliances vent into different chimney flues or vents, test with each successive unit running, that is, as you fire up the next appliance, allow the previous one to operate.
6. If spillage or draft measurement is unacceptable, correct the problem by one of the following methods (listed in order of preference):
    a. Inspect the vent system for blockage or restriction. Correct the problem.
        i As a simple test to determine if the unacceptable spillage or draft test is caused by blockage or excessive negative pressure in the CAZ, open a window or door in the CAZ so that it is well connected to the outdoors. If the cause is for the bad draft or spillage is negative pressure, this will relieve the negative pressure, allowing the vent system to work properly. On the other hand, if the problem is caused by a restriction, the spillage/draft problem will remain. Keep in mind that there is the possibility that the venting problem could be the result of a blockage and excessive negative pressure in the CAZ.
    b. Inspect ducted distribution systems for return leakage in the CAZ. Seal any leakage to make the net worst-case depressurization less severe. Inspect ducted distribution systems for supply leakage in places other than the CAZ. Seal any leakage to make the net worst-case depressurization less severe.
    c. Increase the CAZ air volume by connecting the CAZ to other areas within the conditioned volume of the dwelling (see NFPA 54, NFPA 31, or NFPA 211);

d. Duct outdoor air directly to the burner(s)' combustion supply air port; or
e. Increase the CAZ air volume by connecting the CAZ to the outdoors (see NFPA 54, NFPA 31, or NFPA 211).
f. Supply outdoor air to the CAZ with a supply fan linked to the affected combustion appliance controls.
g. Replace the appliance with one that is more resistant to negative pressure in the CAZ.

7. If the dwelling has other combustion appliance zones, repeat the sequence of activating exhaust equipment, door closure, furnace blower activation, recording pressure readings, etc.
8. When all worst-case depressurization testing has been completed, turn off all exhaust equipment and return doors and combustion appliances to their previous operational settings.
9. Seal any holes that were drilled in the vent connector with appropriate materials.

Table 13-4

Gas Appliances, Category I Acceptable Draft Test Readings for Various Outdoor Temperature Ranges					
ºF	<20	21-40	41-60	61-80	>80
Pascals	-5	-4	-3	-2	-1
Water Column inches	-.02	-.016	-.012	-.008	-.004

Table 13-5

Low-Static Pressure Power Oil Burners Acceptable Draft Readings at Breech	
Draft Reading Location	***Acceptable Draft***
Vent Connector or Breech	-0.04 to -0.06 or -10 to -15 Pascals

13900 Zone Pressure Diagnostics (ZPD)

13910 Introduction

Zone pressure diagnostics testing is performed to answer some fundamental questions: where is the functioning air barrier and how leaky is it? These test procedures can also be used to measure the size of the leakage paths to various house zones. Leaking air often takes a path through two pressure boundaries that have a cavity, or zone, between them. These zones can include attics, basements, garages, knee-wall areas, or attached porch roofs.

ZPD testing is required by the Energy$mart Program in all cases where additional information is needed regarding the relative and absolute leakage of air barriers (pressure boundaries), including attics and attached or tuck-under garages. For example, CFM_{50} air

leakage can be measured through an attic floor before and after air sealing and insulating to determine the effectiveness of the weatherization work. These ZPD procedures are most valuable on dwellings with moderate air leakage, rather than on dwellings with very high or very low air leakage.

ZPD procedures require the measurement of *pressure* differences across air barriers, like the pressure difference between the house and the zone (attic, for example), while the house is depressurized or pressurized by a blower door. The procedures also require the determination of *flows* across air barriers. These flows can be calculated with the steps of the ZPD procedures and a chart. Once these flows are calculated, an estimate of the square inches of leakage through an air barrier can be determined.

13920 Use of Zone Pressure Diagnostics

These procedures can be used with primary and secondary zones. Primary zones are zones to which you have access, such as basements or attics. This access allows you to open a temporary hole or door between the zone and the dwelling or between the zone and the outdoors. For primary zones, ZPD can be conducted because of the following concerns:

1. Air leakage/energy loss concerns. If, after initial tightening of large leaks, the house still has significant, but not obvious, air leakage, performing ZPD can help identify whether the leaks are in the attic floor, the house walls, or through the basement or crawl space walls.
2. Indoor air quality concerns. Examples include air movement from attached or tuck-under garages into a living area, and moisture or soil gas movement from a crawl space into the dwelling.
3. Attics with potential or actual moisture-related problems. This might be the case in the following conditions:
   a. The attic has obvious moisture problems,
   b. The dwelling has evidence of high relative humidity in winter, or
   c. Ice dams are a concern.

Secondary zones are zones to which you have no access, such as porch roofs. This lack of access prevents you from creating a temporary hole between the zone and the dwelling or the zone and the outdoors. Because of this, you cannot determine the flow between secondary zone and the dwelling or outdoors. However, if you are able to insert a pressure hose into the zone, you can measure the pressure difference between the zone and the dwelling or outdoors. Knowing these pressure differences can be helpful, but it can also be misleading. Be cautious when interpreting the results of secondary zone testing.

13930 Test Procedures for Primary Zones

1. Use the color chart for the add-a-hole (flow) method or the black and white chart for the open-a-door method. Each method allows the hole or door to be opened between the house and the zone or between the zone and the outdoors.

a. Each of these charts is by Anthony Cox and Collin Olson is dated May 2006.
b. These charts are available at www.karg.com/papers.htm. A working Excel spreadsheet representing the charts is also available at the above link.

2. Perform the whole-house blower door test before doing any zone pressure diagnostics (ZPD) testing.
   a. If you cannot reach a house pressure difference of 50 Pascals and/or there are obvious large leaks, repair large leaks before any ZPD testing. You must be able to reach a house pressure difference of 50 Pascals in order to do basic ZPD testing, both before and after you create a temporary hole for the add-a-hole test.
   b. If you can reach a house pressure difference of 50 Pascals, but the house is relatively loose for its size, find and seal large leaks before performing ZPD testing.
   c. If the house is relatively tight for a dwelling of its size, there is probably no reason to perform basic ZPD testing for energy reasons. However, there might be reason to perform testing for moisture or for indoor air quality concerns.
3. Identify zone types. ZPD can be done on all primary zones including attics, crawl spaces, basements, and attached or tuck-under garages. ZPD can also be done on some secondary zones, such as porch roofs and cantilevers that will be sealed off from the house.
4. For the detailed ZPD testing procedures, follow the instructions on the charts mentioned above or use the spreadsheet mentioned above.

14000 Energy$mart Tool Requirements/Recommendations

It is important that the right tools are on the worksite so that the work tasks can be done quickly and properly. Additionally, cleanup and worker protective equipment is vital to ensure the safety of occupants and workers. Finally, the proper diagnostic equipment is required on the worksite so that the required tests can be properly done and the resulting the weatherization and health and safety tasks can be carried out effectively.

The tools and supplies in the required tools list below are mandatory. The tools in the recommended tools list are suggested, but not mandatory.

14100 Required Tools

14110 Installing Insulation and Air Sealing

1. One 2" x 50' Clear Mark II hose.
2. Two 3" x 50' Clear Mark II hoses.
3. Twenty feet of 1 ¼" summer-grade tube.
4. Twenty feet of 1 ¼" winter-grade tube.
5. Two 3" steel connectors.
6. Two 3" to 2" steel reducers.
7. Five 2" to 3" hose clamps.
8. Two 2" to 1 ¼" steel nozzles.
9. Two 2 9/16" Lenox wood bits.
10. Two packages of wood plugs.
11. 100 R-Sticks.
12. One zip tool for removing siding.
13. One high capacity insulation machine with shredder, 240 volt setup.
14. One remote control for insulation machine (wireless is preferred, but wired is acceptable).
15. One 2" x 15' pipes, either ABS or steel.
16. InsulShield (IS-1424) or other type of flashing.[18]
17. Two rolls of fiberglass blanket insulation for miscellaneous stuffing.
18. One high capacity generator (12,000 to 15,000 Watt capacity) permanently installed in trailer or truck with insulation blowing machine.

14120 Hand Tools

1. One multi-bit screw driver (10-way) or equivalent.

[18] This material is not appropriate for sealing around chimneys. Metal for sealing around chimneys must be at least 26-gauge galvanized steel. However, this is approved for the insulation dam around a chimney as long as it is kept at least two inches away from the chimney.

2. Two 20 oz. straight claw hammers.
3. Two side cutter pliers for wire cutting.
4. Two 25' tape measures.
5. One speed square and triangle.
6. One pry bar, 12".
7. One time snips, combo cut.
8. Two 50" extension cords.
9. Three extension cords, 10", 25", and 100".
10. One digital camera and batteries.
11. One butane lighter.
12. Two non-contact voltage detectors.
13. One flashlights, rechargeable spotlight.
14. Three ladders, 4', 6' and 21' extension.
15. Four milliamp meters for thermostat anticipator testing.
16. One round inspection mirror.
17. One utility knife with spare blades.
18. Assortment of cordless tools, including drywall screw gun, ½" drill, hammer drill, reciprocating saw, roto zip, and airless finish nailer.
19. One tic tracer.
20. One hand saw.
21. Assortment of drill bits.
22. Six self-feeding bits, 1" 1 ½", 2" and 2 9/16".
23. Assortment of cement bits.
24. Assortment of driver bits.
25. Assortment of nail sets.
26. One 8" lineman's pliers.
27. One long-nose pliers.
28. One small 1/16" copper probe, 3-pack.
29. Six caulking guns.
30. One ½" right angle drill with clutch, at least 3.2 amp.
31. One stitch stapler.
32. Two Rapid 11 hammer tacker (RP-110).
33. ¼" staples for Rapid 11 hammer tacker.
34. 5/16" staples for Rapid 11 hammer tacker.

14130 Cleanup Equipment and Lead-Safe Work Practices

1. One HEPA vacuum for lead safe work.
2. One extra HEPA filter.
3. One Hi-Filtration dust bags for HEPA vacuum.
4. Two vacuums, one Shop Vac and one Yard Vac.
5. One Takmat, white, 24" x 36", TMW-2436 2-30 sheet.
6. One Zipwall 12" SLP facility pack, ZW-FPK.

7. Two heavy-duty Zipwall zippers, 83", ZZ-HD.
8. One Zipwall side seal pack, ZW-SSP.
9. One ZW-4-Plus.
10. Two Zipwall T-clips, package of 2, ZW-TCLIP1.
11. One Flame resistant poly film, 11' x 100', PFR-11-100.
12. One carpet protections 24" x 100', CP-24-0200.
13. One LeadCheck, 16-swab kit.

14140 Worker Safety

1. North first aid kit (12-300-1).
2. Six negative pressure respirators.
3. Twenty-five Tyvec suits.
4. Six sets of shoe covers.
5. Six 10-packs, dust masks (3M 8271).
6. Six goggles/eye protection.
7. Six sets of knee-pads.
8. One pair of veterinarian gloves.
9. One box of disposable gloves, 50 per box.

14150 Diagnostic Equipment

1. Three blower door kits with digital gauges.
2. One exhaust fan flow measurement device.
3. One hose kit for measuring pressures.
4. Two pressure pans for measuring duct leakage.
5. Two static pressure tips.
6. Two smoke puffers.
7. Two combustible gas detector instruments.
8. Two soap bubble bottles for verifying gas leaks.
9. Two combustion analyzers with printer.
10. Four pocket thermometers.
11. One infrared camera.

14160 Mobile Home Weatherization

1. Two Lexan sidewall stuffers for mobile home walls (1/4" thick, 12" wide, 9' long).
2. Two whitewash brushes with broom handle.
3. Two #6 RCD mastic, two-gallon size.

14200 Recommended Tools

14210 Hand Tools

1. One LED flashlight or equivalent.
2. One power brad nailer.
3. Assorted batteries for use in all battery powered equipment and tools.
4. One set of scaffolding.
5. Three scaffolding planks.
6. One table saw.
7. One electric miter saw.
8. One reciprocating saw.
9. Air compressor if air tools are being used.
10. Two glass cutters.
11. One tin bender.

14220 Diagnostic Equipment

1. One duct blower for testing ductwork.
2. One ZipTest Pro^3 software loaded into Texas Instruments TI-89 calculator, field-ready iPad, or equivalent with software.
3. Two Watts Up electric meter or electric usage data logger or equivalent.

15000 Weatherization Personnel

15100 *Program Personnel Knowledge, Skills, and Abilities*

The competencies and skills of New Mexico Energy$mart Program weatherization personnel are important to define and achieve. The field of low-income weatherization has changed significantly during that last ten years; it is important that weatherization staff adjust to these changes. The introduction of *Weatherization Plus* by DOE and the increased use of building science principles and procedures into the weatherization field have accelerated these changes. The weatherization personnel knowledge, skills, and abilities listed in this section ensure that New Mexico weatherization staff remain at the forefront of this trend and bring the professionalism to their work that clients deserve.

Knowledge, Skills, and Abilities (KSAs)

1. KSAs identify the minimum knowledge, skills, and abilities that a skilled worker should possess to perform high quality weatherization work.
2. Efforts should be made by the New Mexico MFA to provide training and other activities that allow the Energy$mart weatherization personnel to achieve these minimum KSAs.
3. Energy$mart weatherization personnel should strive to achieve the level of professionalism inherent in these KSAs. These efforts include the following services:
   a. Providing appropriate training opportunities.
   b. Setting up and maintaining a process for certification and certification renewal.
4. Over time, these KSAs will evolve: more items will be added, and some may be dropped from the lists that follow.
5. The knowledge, skills, and abilities listed in this section are from Part II of *Workforce Guidelines for Home Energy Upgrades*, published by the Department of Energy in 2011.

The weatherization job categories included in this section are:

1. Weatherization manager
2. Energy auditor
3. Crew leader
4. Installer
5. Final inspector
6. Energy educator

Agencies must update their job descriptions and hiring process to reflect the knowledge, skills, and abilities by position.

15110 Weatherization Manager

The Weatherization Manager at an agency is responsible for making the weatherization program work. They should know their staff and be aware of most of what their staffs' required knowledge, skills, and abilities. In addition to checking the budget and ensuring that all the required papers are in order, the Weatherization Manager should inspire, lead, and motivate their staff. It is important that the Weatherization Manager understand that they set the tone for the entire weatherization program at their agency.

1. Prerequisites:
    a. Knowledge of safe work practices and competencies required by others on manager's staff.
2. Possess a working knowledge of:
    a. DOE program regulations 10 C.F.R. 440.
    b. New Mexico Program Operations Manual.
    c. New Mexico Program Weatherization Standards.
    d. Weatherization agency contracts;
    e. Applicable state and local agency procurement regulations.
    f. State and local approaches to monitoring, training, and technical assistance.
    g. Applicable computer databases, reporting forms and procedures, and production and expenditure tracking systems and the importance that they remain up-to-date, are secured and backed-up, and are used effectively to manage the program.
3. Demonstrate the ability to:
    a. Effectively communicate and manage weatherization staff.
    b. Act as a public relations spokesperson for the program to leverage resources for the Weatherization Program from both public and private sources.
    c. Prepare and track a budget for implementing a local weatherization program.
    d. Prepare a Management Plan and Production Schedule for implementing a local weatherization program.
    e. Ensure that weatherization work complies with state technical program standards.
    f. Ensure rigorous, unbiased, and accurate final inspection of all completed units.
    g. Coordinate all program resources, including materials, vehicles, tools and equipment, warehousing, and personnel.
    h. Comply with budget line item requirements.
    i. Maintain a purchase order system to track contracted services and materials and tool requisitions.
    j. Maintain a coding system to assure expenditures are charged to the correct budget category.
    k. Maintain inventory tracking system for materials, tools, and equipment
    l. Submit accurate financial and production reports in a timely manner
    m. Maintain client file documents as per state guidelines
    n. Schedule crews and jobs to meet production goals and compliance with program priorities
    o. Manage a small construction/production-focused operation

p. Provide adequate technical training for auditors, technicians, and inspectors directly employed by the local agency, and ensure that subcontractors receive appropriate technical training.
q. Develop and implement innovative leveraging strategies.

15120 Energy Auditor

An Energy Auditor is a building analyst that evaluates and analyzes buildings and their energy efficiency, and health and safety aspects by gathering empirical data, conducting tests and using energy modeling software with the goal of identifying areas for savings, reducing energy consumption, improving health and safety, and increasing the lifespan of a building while also improving the quality of life and comfort for building occupants.

15121 Demonstrating Professional Energy Auditor Conduct

1. Establish Client Relations for an Energy Audit
   a. Ability to:
      i. Conduct client introductions
      ii. Conduct client interviews
      iii. Complete client questionnaires
      iv. Explain the purposes of the visit
      v. Set the client expectations and responsibilities (pre and post audit)
      vi. Establish the client plan of action
      vii. Engage the client in the actual testing
      viii. Obtain client signatures on forms (lead forms, etc.)
      ix. Serve as a liaison between the client and the contractors
      x. Ability to work independently
   b. Knowledge of:
      i. Building science
      ii. Codes of conduct
      iii. Forms (Lead safety forms, etc.)
      iv. Funding sources/financing
      v. Health and safety issues
      vi. Interviewing techniques
      vii. The program, agency or organization which the energy auditor represents
   c. Skills in:
      i. Communication
      ii. Listening
      iii. Presenting information
      iv. Time management
2. Represent the Program/Agency/Organization
   a. Ability to:
      i. Communicate with crews and subcontractors
      ii. Complete program/agency/organization reports
   b. Knowledge of:

i. Construction processes and techniques
ii. Program reports

c. Skill in:
i. Communication

3. Maintain Professionalism
a. Ability to:
i. Complete continuing education
ii. Maintain certifications
iii. Acquire new certifications

b. Knowledge of:
i. Appropriate dress for the situation
ii. Certification requirements for energy auditors
iii. Continuing education requirements for energy auditors

15122 Collecting Building Information for an Energy Audit

1. Document energy consumption
a. Ability to:
i. Obtain 12 months of client utility bills
ii. Obtain annual fuel delivery information (oil, propane, etc.)

b. Knowledge of:
i. How to access utility information
ii. Utility bill component interpretation

c. Skill in:
i. Calculating baseloads, the area and volume of building spaces, etc.
ii. Basic math

2. Document the building history
a. Ability to:
i. Determine the age of the original structure
ii. Determine the age of any additions or improvements
iii. Determine if the building has any historical significance

b. Knowledge of:
i. How to access building permit history
ii. How to access tax files

3. Conduct a physical/visual inspection
a. Ability to:
i. Walk around the exterior of the building
ii. Locate holes, chimneys, gutters, vent pipes, soffits, fascia, peeling paint, foundation integrity, areas of infiltration and exfiltration, exhaust fan penetrations, accesses, crawlspaces, roof vents, land grading, shading, building orientation, anomalies
iii. Walk around the interior of the building

iv. Check for pest/vermin infestations, evidence of leaking or water damage, holes, chimneys, vent pipes, peeling paint, foundation integrity, areas of infiltration and exfiltration, exhaust fan penetrations, accesses, crawlspaces, roof vents, structural damage
v. Identify hidden rooms or spaces
vi. Determine the exterior façade materials (siding, brick, etc.)
vii. Identify issues that would interfere with or prevent tests
viii. Identify hazardous materials in the building
ix. Identify health and safety issues (clutter, bleach stored next to a furnace, etc.)
x. Perform visual inspection of vented combustion appliance venting configuration
xi. Detect unusual odors
xii. Photograph and document conditions

b. Knowledge of:
i. General construction
ii. Codes and standards adopted by the local jurisdiction
iii. Combustion appliance venting procedures
iv. Hazardous materials
v. Issues that pose a health and/or safety risk
vi. NFPA 211
vii. Situations that pose a health and/or safety risk
viii. Effects of moisture
ix. Sources of moisture
x. What to look for when conducting a physical/visual inspection

c. Skill in:
i. Attention to detail

4. Collect appliance information

a. Ability to:
i. Collect refrigerator/freezer label data and documentation
ii. Collect heating/cooling appliance label data and documentation
iii. Identify heating/cooling appliance fuel type
iv. Collect domestic water heater label data and documentation
v. Collect washer/dryer label data and documentation
vi. Collect mechanical ventilation label data and documentation
vii. Collect dishwasher label data and documentation
viii. Collect shower head flow rates
ix. Collect dehumidifier label data and documentation
x. Collect stove/oven appliance label data and documentation
xi. Identify stoves/ovens appliance fuel type
xii. Collect unvented space heater label data and documentation
xiii. Identify other components related to the HVAC appliances (expansion tanks, fill valves, remote compressors, etc.)

xiv. Identify other components related to the domestic water heater appliance (storage tanks, mixing valves, etc.)
xv. Identify safety features related to the HVAC and domestic water heater appliances

b. Knowledge of:
i. Appliances
ii. Codes and standards adopted by the local jurisdiction
iii. Domestic water heater components and operation
iv. Heating/cooling system How to read a meter
v. How to read and interpret appliance labels
vi. Mechanical ventilation equipment
vii. Safety issues associated with domestic water heaters
viii. Shower head operations and flow rates
ix. Various appliance fuel types

c. Skill in:
i. Penmanship
ii. Attention to detail

5. Collect electrical baseload data
a. Ability to:
i. Conduct a lighting audit
ii. Count the number of people in the house
iii. Determine if dishwasher is present
iv. Determine if the domestic water is fuel fired or electric
v. Collect client lifestyle information (TV usage, Xboxes, etc.)
vi. Meter the refrigerator
vii. Look for additional usage sources (hot tubs, pool pumps, pool heaters, fish ponds, fountains, etc.)

b. Knowledge of:
i. Fuel-fired versus electric domestic water heaters
ii. How lifestyle affects energy consumption
iii. How to analyze a utility bill
iv. How to diagnose high electric/gas usage
v. How to read an electric meter
vi. Refrigerator gasket seal conditions

c. Skill in:
i. Basic math

6. Collect building measurements
a. Ability to:
i. Measure walls
ii. Measure roofs
iii. Measure windows
iv. Measure doors
v. Measure perimeter

vi. Measure radiators
vii. Measure foundation height
viii. Measure attic venting
ix. Measure attic spaces
x. Measure area and volume of the building envelope

b. Knowledge of:
i. How to calculate the area and volume of the building envelope
ii. How to identify the pressure boundary
iii. How to identify the thermal boundary
iv. How to measure building components (doors, windows, etc.)
v. Various building components

c. Skill in:
i. Measuring
ii. Attention to detail
iii. Basic math

7. Collect health and safety data

a. Ability to:
i. Locate existing smoke/CO alarms
ii. Determine age of smoke/CO alarms
iii. Determine if smoke detectors/CO are hardwired or battery
iv. Verify clothes dryer is properly vented to exterior
v. Verify all exhaust fans are properly vented to exterior
vi. Identify existence of any possible hazardous materials/conditions
vii. Identify knob-and-tube wiring
viii. Identify moisture issues (standing water, condensation, plumbing leaks, mold, etc.).
ix. Identify electrical hazards (frayed wiring, open junction boxes, unkempt wires, overloaded circuits, etc.)
x. Identify suspect asbestos
xi. Identify lead-based paint hazards
xii. Identify propane-fueled appliances
xiii. Identify unvented combustion appliances
xiv. Identify properly operating back draft damper

b. Knowledge of:
i. Proper locations for smoke/CO alarms
ii. Venting requirements for appliances
iii. Conditions that signify moisture
iv. Domestic water heater safety
v. Electrical hazards
vi. Hazardous materials
vii. Heating system safety
viii. How to determine if knob-and-tube wiring is active
ix. Issues and hazards associated with asbestos

x. Issues and hazards associated with lead based paint
xi. Water heater regulations for manufactured homes
xii. Rules and regulations pertaining to lead and asbestos
xiii. Smoke/CO alarm operations

8. Collect mechanical ventilation data
   a. Ability to:
      i. Review manufacturer's specifications for exhaust fans
      ii. Determine the volume of the affected space
      iii. Determine the type of control
      iv. Identify the size of the registers/grilles
      v. Determine condition of the ventilation ductwork/piping (pitch, insulation, size, material, elbows, length to run, etc.)
      vi. Calculate volume
   b. Knowledge of:
      i. The different controls and motors
      ii. Types of ventilation materials
      iii. Ventilation ductwork
      iv. Ventilation standards and local codes
9. Identify building insulation (attic, walls, floors and foundation)
   a. Ability to:
      i. Identify insulation type
      ii. Identify insulation amount (thickness, etc.)
      iii. Identify insulation condition
      iv. Identify presence and placement of vapor retarder
      v. Identify location of insulation (exposure, aligned with pressure boundary, etc.)
      vi. Identify areas of insulation opportunities for savings
      vii. Probe
      viii. Work in confined spaces
   b. Knowledge of:
      i. Building science
      ii. Insulation effectiveness
      iii. Insulation R-Values
      iv. Insulation placement
      v. OSHA safety requirements
10. Collect attic data
   a. Ability to:
      i. Identify attic components
      ii. Measure attic/roof cavities
      iii. Measure attic areas
      iv. Measure attic framing
      v. Determine existing ventilation (soffit, can, ridge, type and size, power ventilators, etc.)

vi. Identify sources/signs of water damage
vii. Identify air leakage points
viii. Identify point(s) of access
ix. Identify electrical hazards
x. Identify pest/vermin infestations
xi. Determine structural integrity
xii. Identify whole-house cooling fan
xiii. Determine attic uses
xiv. Note the existence of radiant barriers
xv. Identify existence of baffles
xvi. Use ladders
xvii. Work in confined spaces

b. Knowledge of:
i. Attic components
ii. Electrical hazards
iii. General construction terms
iv. How to calculate the area and volume of building spaces
v. Air leakage points
vi. Safety hazards in an attic (nails, rafters, heat exposure, etc.)
vii. Signs of water damage
viii. Signs of pest/vermin infestations
ix. Thermography
x. Types of ladders based on the situation
xi. Ventilation requirements

11. Collect wall data
a. Ability to:
i. Identify wall type (interior, exterior, components)
ii. Identify framing method
iii. Measure wall areas
iv. Identify wall orientation
v. Identify cavity depth
vi. Identify source and signs of any water damage
vii. Identify infiltration points
viii. Identify signs of pest/vermin infestation
ix. Identify orientation using online mapping tools
x. Use a compass

b. Knowledge of:
i. General construction
ii. Building science
iii. Compass orientations
iv. Air leakage points
v. Typical wall framing and components

c. Skills in:
    i. Basic math
    ii. Logical thinking

12. Collect window data
    a. Ability to:
        i. Identify window type (jalousie, awning, single-hung, double hung, etc.)
        ii. Identify window frame type
        iii. Identify window glazing type
        iv. Identify exterior shading
        v. Identify window operation/leakiness
        vi. Measure window area
        vii. Count number of windows
        viii. Identify window orientation
        ix. Identify general window conditions
    b. Knowledge of:
        i. Code requirements pertaining to window glazing (walkways, etc.)
        ii. OSHA safety requirements
        iii. State Historic Preservation Office (SHPO) requirements
        iv. Window construction, components and nomenclature
13. Collect door data
    a. Ability to:
        i. Identify door type and swing
        ii. Measure door area
        iii. Count number of doors
        iv. Identify door conditions
        v. Identify condition of door sweep and weatherstripping
        vi. Identify door hardware condition
    b. Knowledge of:
        i. Door components, hardware and nomenclature
        ii. Door construction
        iii. Door operation and adjustments
    c. Skill in:
        i. Basic math
14. Collect foundation data
    a. Ability to:
        i. Identify foundation types (crawlspace, basement, or slab)
        ii. Identify foundation materials
        iii. Measure floor areas
        iv. Identify infiltration points
        v. Measure exposed walls
        vi. Measure thickness of foundations
        vii. Identify sources and signs of moisture

viii. Identify points of access
ix. Identify electrical hazards
x. Identify signs of pest/vermin infestations
xi. Determine structural integrity
xii. Identify special equipment (sump pumps, etc.)
xiii. Measure the crawlspace ventilation
xiv. Record the location of any plumbing pipes
xv. Work in confined spaces

b. Knowledge of:
i. General construction
ii. Basic electricity
iii. Basic plumbing
iv. Building science
v. Codes and standards adopted by the local jurisdiction
vi. Crawlspace ventilation requirements, if any
vii. Foundation construction materials and methods
viii. OSHA safety requirements
ix. Potential sources of moisture
x. Signs of moisture
xi. Signs of pests/vermin
xii. Signs of structural hazards on foundations
xiii. Structures typically found in foundations
xiv. Types of foundations

c. Skills in:
i. Observation

15. Collect roof data

a. Ability to:
i. Identify roof conditions
ii. Identify roof color
iii. Identify roofing materials (90 lb. paper, rubber, etc.)
iv. Identify condition of parapet walls
v. Identify roof penetrations
vi. Identify roof debris (garbage, old air conditioners, etc.)
vii. Identify roof ventilation (passive vents)
viii. Identify roof drainage
ix. Identify roof pitch
x. Measure roof area
xi. Note flashing condition
xii. Identify roof access
xiii. Identify roof exposure and orientation
xiv. Identify roof insulation (flat roof with no cavity and with rigid insulation)
xv. Work at heights

xvi. Determine roof pitch
xvii. Measure areas

b. Knowledge of:
i. General construction
ii. Insulation materials and methods
iii. OSHA safety requirements
iv. Roofing construction methods
v. Roofing materials

15123 Testing the Building for an Energy Audit

1. Prepare for the test
   a. Ability to:
      i. Determine the test(s) to be performed
      ii. Inform the client of the test(s)
      iii. Gather the test tools/equipment
      iv. Prepare the building for testing based upon manufacturer's test equipment specifications
      v. Understand manufacturer's specifications
      vi. Use test equipment
   b. Knowledge of:
      vii. Building diagnostic testing
      viii. Building science
      ix. Test equipment
      x. Test protocols
   c. Skill in:
      i. Attention to detail
      ii. Communication
2. Meter the appliances
   a. Ability to:
      i. Inspect appliances for test accessibility
      ii. Plug appliances into the Watt-hour meter
      iii. Follow the manufacturer's guidelines for operation of the Watt-hour meter
      iv. Document findings with pictures/forms
      v. Read and interpret a Watt-hour meter
   b. Knowledge of:
      i. Electric appliance metering
      ii. Electric appliance safety
3. Conduct indoor air quality tests
   a. Ability to:
      i. Monitor the ambient CO tests throughout the building
      ii. Record the highest ambient CO reading
      iii. Find the source of the CO

iv. Determine if the reading exceeds any applicable action levels
v. Identify conditions that promote mold growth (high humidity, cold surface condensation, etc.)
vi. Follow odors to find source of mildew
vii. Visually identify presence of mold-like substance
viii. Identify conditions that promote radon infiltration
ix. Measure the flow of mechanical ventilation
x. Document findings with pictures/forms
xi. Communicate meter results with clients
xii. Remain calm under stressful situations

b. Knowledge of:
i. ASHRAE maximum allowable CO exposure for living areas
ii. Carbon monoxide exposure symptoms
iii. Conditions that promote mold growth
iv. Conditions that promote radon infiltration
v. EPA action levels
vi. How to measure mechanical ventilation
vii. NIOSH recommended limit for occupational CO exposure
viii. OSHA permissible exposure limits

c. Skill in:
i. Remaining dedicated to the cause
ii. Detecting unusual odors

4. Perform combustion safety and efficiency tests
a. Ability to:
i. Visually inspect the fuel supply lines
ii. Test for leakage in the fuel supply pipes
iii. Verify leaks with bubble solution
iv. Perform worst-case depressurization test
v. Perform combustion spillage tests
vi. Perform draft tests
vii. Conduct combustion efficiency tests (oxygen, net stack temperature)
viii. Measure undiluted CO in combustion appliances
ix. Document findings with pictures/forms
x. Identify various heating systems
xi. Work in confined spaces

b. Knowledge of:
i. Backdraft test protocols
ii. Building science
iii. Codes and standards adopted by local jurisdiction
iv. Combustion efficiency tests
v. Fuel-line leak testing techniques
vi. Heating system configurations

vii. How to conduct draft tests
viii. How to inspect fuel supply lines
ix. How to measure CO in appliances
x. Nationally recognized combustion safety test protocols (BPI, Energy Outwest, Midwest Best Practices, etc.)
xi. Four vent categories as defined by the National Fuel Gas Code (NFPA 54)
xii. Various venting methods and three draft types
xiii. Understanding of "worst case" depressurization and how to achieve

5. Perform blower door test
   a. Ability to:
      i. Perform pre-blower door interior thermographic scan
      ii. Perform pre-blower door exterior thermographic scan
      iii. Follow manufacturer's specifications for conducting blower door tests
      iv. Perform thermographic scan during the blower door operation
      v. Perform zone pressure diagnostics (ZPD) to attic and attached garage
      vi. Locate points of infiltration/exfiltration
      vii. Document findings with pictures/forms
      viii. Determine the cost effective level of air sealing
      ix. Interpret blower door results
   b. Knowledge of:
      i. Advanced blower door diagnostics
      ii. Blower door testing procedures (pressurization, depressurization, etc.)
      iii. How to assemble and operate a blower door
      iv. How to evaluate zone pressures
      v. Thermography
      vi. Air sealing limit standards (AST and DTL)
   c. Skill in:
      i. Basic math
6. Perform HVAC distribution tests
   a. Ability to:
      i. Perform forced air system distribution leakage test
      ii. Verify with building occupants if there is adequate heating and cooling in the building
      iii. Measure room temperatures
      iv. Measure the temperatures of the hydronic radiators
      v. Perform air flow tests at the registers
      vi. Measure temperature rise across heat exchangers
      vii. Measure external static pressure of distribution system
      viii. Inspect hydronic distribution (high, low, valves, etc.)
      ix. Measure hydronic distribution (radiators, fin tube, etc.)
      x. Perform pressure-balancing rooms tests (ducted air systems)
      xi. Document findings with pictures/forms
      xii. Work in confined spaces

b. Knowledge of:
    i. HVAC testing protocols
    ii. Air flow
    iii. How to measure hydronic distribution
    iv. HVAC terminology
    v. Hydronic heating
    vi. Manufacturer's specifications for forced air distribution systems
    vii. Distribution system design
c. Skill in:
    i. Communication
    ii. Attention to detail

15124 Evaluating Collected Energy Audit Data

1. Evaluate the health and safety of the building
    a. Ability to:
        i. Review collected data to determine if there is health and safety concern
        ii. Determine if health and safety issues can be addressed through an energy-efficiency measure and therefore can fall within energy funding
        iii. Determine the repairs needed
        iv. Review the economics of the repairs to determine whether to repair or to defer
    b. Knowledge of:
        i. How to deal with special circumstances (mold, lead, asbestos, etc.)
        ii. Construction repair methods
        iii. Costs associated with repairs
        iv. Energy funding
    c. Skill in:
        i. Basic math
        ii. Cost estimating
2. Evaluate the durability/structural integrity of the building
    a. Ability to:
        i. Review collected data to determine if there is a durability/structural integrity issue
        ii. Determine if the durability/structural integrity issues can be addressed through an energy-efficiency measure and therefore can fall within energy funding
        iii. Determine the durability/structural integrity repairs
        iv. Review the economics of the repairs to determine whether to repair or to defer
    b. Knowledge of:
        i. Codes and standards adopted by local jurisdiction
        ii. Costs associated with structural repairs

iii. Energy funding
iv. Structural repair methods 9.21

c. Skill in:
i. Basic math
ii. Cost estimating

3. Evaluate the HVAC system
a. Ability to:
i. Review collected data to determine if there is a HVAC system problem
ii. Evaluate the HVAC system for health and safety concerns
iii. Evaluate HVAC sizing for potential replacement or upgrades
iv. Evaluate the distribution (add trunk lines, radiators, etc. to rooms as needed)
v. Evaluate fuel switching options
vi. Evaluate the need to clean and tune versus replace
vii. Evaluate the need for and supply of combustion air
viii. Evaluate the HVAC system for other issues that lead to replacement or upgrades (condition, age, efficiency, etc.)
ix. Identify duct sealing/insulation and pipe insulation opportunities
x. Interpret software output
xi. Perform load calculations

b. Knowledge of:
i. Air Conditioning Contractors of America (ACCA) manuals
ii. Btu content of fuels
iii. Energy funding
iv. Heating/cooling system operations
v. How to size HVAC systems
vi. HVAC load calculations
vii. HVAC system repair, replacement or upgrade costs
viii. Maximum allowable duct leakage
ix. Safety requirements

c. Skill in:
i. Basic math
ii. Communication
iii. Attention to detail

4. Evaluation of mechanical ventilation
a. Ability to:
i. Review collected data to determine mechanical ventilation issues
ii. Compare flow with ventilation specifications
iii. Compare blower door results against IAQ standards
iv. Assess the need for and placement of additional mechanical ventilation
v. Assess the make-up air source and whether it needs to be filtered
vi. Determine the mechanical ventilation repairs, replacement and/or addition

vii. Review the economics of the repairs, replacements and/or additions to determine whether to proceed or to defer
viii. Determine the type of ventilation controls needed

b. Knowledge of:
i. Ventilation standard (ASHRAE 62.2)
ii. Funding for ventilation systems
iii. IAQ standards
iv. Mechanical ventilation controls
v. Types of ventilation
vi. Ventilation flow
vii. Ventilation sizing

c. Skill in:
i. Basic math

5. Evaluate baseload energy use
a. Ability to:
i. Review collected data to determine if replacements or upgrades will reduce energy consumption
ii. Consider energy-efficient light bulbs for installation
iii. Review refrigerator/freezer data for economics of replacement
iv. Review domestic water heaters for economics of replacement or repair
v. Review domestic water heater pipe insulation opportunities
vi. Review domestic water heater insulation opportunities
vii. Review water-saving opportunities (water saving shower heads, etc.)
viii. Review domestic water heater thermostat setting

b. Knowledge of:
i. Codes and standards adopted by local jurisdiction
ii. Components of baseloads
iii. Energy funding
iv. How to calculate baseloads
v. Pipe insulation

6. Evaluate the foundation
a. Ability to:
i. Review collected data to determine foundation issues
ii. Determine repairs needed
iii. Review economics of repairs
iv. Determine proper insulation location (floor or wall)
v. Evaluate crawlspace venting needs (if any)
vi. Evaluate box sill insulation needs
vii. Determine if perimeters need to be insulated
viii. Identify type of insulation materials to be added
ix. Calculate if adequate ventilation exists or should be added
x. Evaluate the need for a ground cover (if any)

b. Knowledge of:

i. Building science
ii. Codes and standards adopted by local jurisdiction
iii. Energy funding
iv. Foundation construction techniques
v. Foundation crawlspace ventilation
vi. Foundation insulation
vii. Foundation types
viii. Foundation vapor barriers/retarders (if any)

7. Evaluate the walls
   a. Ability to:
      i. Review collected data to determine wall issues
      ii. Evaluate repairs needed and structural integrity
      iii. Review the economics of repairs to determine whether to repair or defer
      iv. Determine proper insulation levels
      v. Identify type of insulation materials to be added
      vi. Determine square footage of area to be insulated
      vii. Ensure pressure plane and thermal boundary align
      viii. Ensure the vapor retarder is appropriately placed
   b. Knowledge of:
      i. EPA and DOE lead and asbestos standards
      ii. Building science
      iii. Codes and standards adopted by local jurisdiction
      iv. Energy funding
      v. Insulation types and appropriateness
      vi. Pressure planes and thermal boundaries
      vii. Typical wall structures
      viii. Vapor barriers/retarders in walls (if any)
8. Evaluate the attic
   a. Ability to:
      i. Review collected data to determine attic issues
      ii. Evaluate structural integrity and repairs needed
      iii. Review economic of repairs to determine whether to repair or defer
      iv. Review insulation location
      v. Review insulation type
      vi. Evaluate whether insulation is appropriate for use
      vii. Ensure pressure boundary and thermal boundary align (air sealing)
      viii. Ensure the vapor retarder is appropriately placed (if needed)
      ix. Evaluate attic ventilation, existing and required
      x. Assess fire hazards (lighting cans, electrical, etc.)
      xi. Evaluate the need for service access
   b. Knowledge of:
      i. Attic construction and materials

ii. Attic fire hazards
iii. Attic types
iv. Attic ventilation
v. Building science
vi. Codes and standards adopted by local jurisdiction
vii. Energy funding
viii. Insulation types and appropriateness
ix. Pressure planes and thermal boundaries
x. Vapor barriers/retarders and their purpose

9. Evaluate the doors
   a. Ability to:
      i. Review collected data to determine door issues
      ii. Evaluate repairs needed and structural integrity (can frame support door replacement, etc.)
      iii. Review economics of repairs to determine whether to repair or replace
      iv. Evaluate the condition of storm doors (closers, etc.)
   b. Knowledge of:
      i. Codes and standards adopted by local jurisdiction
      ii. Door framing structures and processes
      iii. Door types
      iv. Energy funding
      v. Glass types
10. Evaluate the windows
   a. Ability to:
      i. Review collected data to determine window issues
      ii. Evaluate repairs needed and structural integrity
      iii. Review economic of repairs to determine whether to repair or replace
      iv. Evaluate window components and performance
   b. Knowledge of:
      i. Building science
      ii. Codes and standards adopted by local jurisdiction
      iii. Energy funding
      iv. Window components
      v. Window glazing
      vi. Window types
11. Enter data into energy audit software tool
   a. Ability to:
      i. Gather all information and data pertaining to the audit
      ii. Enter the data into energy audit software tool, NEAT or MHEA
      iii. Analyze the output from the software
      iv. Produce a cost and savings report
      v. Use a computer

b. Knowledge of:
    i. Basic construction terms
    ii. Building science
    iii. Energy audit software tool, NEAT and MHEA

12. Determine the work scope
    a. Ability to:
        i. Determine the health and safety measures
        ii. Determine the building durability measures
        iii. Determine the energy measures based on the SIR
        iv. Provide analysis reports (work order)
        v. Create reports
        vi. Create work specifications
    b. Knowledge of:
        i. Building science
        ii. Codes and standards adopted by local jurisdiction
        iii. Construction practices and terms
        iv. Energy modeling software
        v. Program rules and standards
    c. Skill in:
        i. Computer usage

15130 Crew Leader

A crew leader is responsible for supervising the retrofitting activities specified in the scope of work. He or she is responsible for interacting with the client in addition to managing personnel and materials on the job site in a safe and effective manner. The crew leader is responsible for quality control, testing procedures, documentation, and conducting a final walk through to ensure that all work is completed in a satisfactory manner.

15140 Installer

An installer installs energy-efficiency measures to single family or 2-4 unit-homes using a variety of building science practices and weatherization techniques. It is important for the installer (or subcontractor) to understand that they are on the “front line” of the weatherization program; if they do substandard work, the weatherization program cannot be effective. On the other hand, if they perform good work, their weatherization program will be successful. Additionally, it is important for the installer or subcontractor to keep in mind that they are ambassadors for their weatherization agency and for the larger weatherization program.

15141 Maintain Safety

1. Follow work rules of jurisdiction having authority

a. Ability to:
    i. Read or hear safety documents
    ii. Implement safety procedures
    iii. Report safety concerns and violations
    iv. Wear safety equipment
    v. Attend safety meetings/trainings
    vi. Request safety training
    vii. Install safety guards
b. Knowledge of:
    i. Installation procedures
    ii. Manufacturer's specifications
    iii. OSHA
    iv. Safety systems

2. Handle materials/equipment according to manufacturer's specifications
    a. Ability to:
        i. Read or hear manufacturer's specifications or MSDS
        ii. Store or maintain materials/equipment according to manufacturer's specifications
    b. Knowledge of:
        i. Manufacturer's specifications
3. Handle tools according to manufacturer's specifications
    a. Ability to:
        i. Read or hear manufacturer's specifications or MSDS
        ii. Store or maintain materials/equipment according to manufacturer's specifications
    b. Knowledge of:
        i. Manufacturer's specifications

15142 Prepare for the Job Before Arriving at Job Site

1. Attend training
    a. Ability to:
        i. Participate in training
        ii. Identify self-strengths and weaknesses
        iii. Modify installation practice based on training
        iv. Sign in to training
    b. Knowledge of:
        i. Existing practice
        ii. Safety procedures
2. Gather materials and supplies
    a. Ability to:
        i. Review materials list
        ii. Compare materials to work scope

iii. Verify and protect the condition of materials
iv. Organize materials
v. Report missing or deficient materials

b. Knowledge of:
i. Compatibility
ii. Material handling
iii. Materials
iv. Material limits
v. MSDS
vi. Physical limits of materials
vii. Work scope

3. Gather tools
a. Ability to:
i. Review tool list
ii. Compare tools to work scope
iii. Verify and protect tool condition
iv. Load and unload tools
v. Report missing or deficient tools
vi. Modify tools for specific job requirements

b. Knowledge of:
i. Work scope
ii. Manufacturer's specifications
iii. Materials handling
iv. Lifting safety
v. Normal tool operations

15143 Prepare and Maintain Tools and Materials at Site

1. Set up tools
a. Ability to:
i. Unload tools from vehicle
ii. Connect attachments
iii. Plug in tools
iv. Verify operational status
v. Perform routine maintenance
vi. Report deficiencies

b. Knowledge of:
i. Carrying techniques
ii. Double insulated tools
iii. Electrical safety
iv. GFCI
v. Lifting techniques

vi. Manufacturer's specifications
vii. Normal operations
viii. Tool recognition
ix. Work scope

2. Set up materials
   a. Ability to:
      i. Unload materials from vehicle
      ii. Organize materials
      iii. Confirm materials match work scope
      iv. Maintain integrity of materials
      v. Report deficiencies
   b. Knowledge of:
      i. Job site
      ii. Lifting techniques
      iii. Materials
      iv. Materials limits and characteristics
      v. Work scope

15144 Prepare and Maintain Job Site

1. Attend job site safety meeting
   a. Ability to:
      i. Attend
      ii. Participate
      iii. Sign in
2. Implement safety protocol (rigging, ventilation, blocking)
   a. Ability to:
      i. Set up safety masking an drop cloths
      ii. Set up ventilation in confined spaces
      iii. Set up task lighting
      iv. Hook up to fall protection
      v. Set up ladders, scaffolding, climbing equipment
      vi. Put on personal protective equipment
      vii. Lock out/tag out
      viii. Inspect work area for hazards
      ix. Report work area hazards
   b. Knowledge of:
      i. Combustibles
      ii. Confined spaces
      iii. Electrical safety
      iv. EPA lead safety
      v. Equipment operation

vi. Fall protection
vii. Fit test
viii. Hazard recognition
ix. Lanyards
x. Local codes
xi. Manufacturer's specifications
xii. Materials
xiii. OSHA
xiv. Personal protection
xv. Safety protocols
xvi. Ventilation systems and requirements
xvii. Work scope

3. Use protective barriers (drop clothes)
   a. Ability to:
      i. Move furniture (confirm permission)
      ii. Cover furniture/storage areas/clothes in closets
      iii. Protect furniture
      iv. Protect floors
      v. Follow safe practices, including lead safe practices
      vi. Place drop cloths, tack mats
      vii. Use designated facilities (eating, bathroom, smoke break)
   b. Knowledge of:
      i. Adjacent characteristics
      ii. Electronics
      iii. EPA lead safety
      iv. Flooring characteristics
      v. Lifting techniques
      vi. Materials characteristics
      vii. Safe practices
      viii. Work scope
4. Report Pre-existing conditions that are not in work scope
   a. Ability to:
      i. Identify pre-existing conditions (aesthetic/structural)
      ii. Report pre-existing conditions
      iii. Report difficult-to-access places
   b. Knowledge of:
      i. General construction
      ii. Work scope
5. Protect exterior environment
   a. Ability to:
      i. Control dust and debris created by equipment from construction activities
      ii. Protect landscaping

iii. Check for oil leaks
iv. Report mishaps (spills, cracks)

b. Knowledge of:
i. Work scope
ii. Retaining walls
iii. General landscape knowledge
iv. Containment requirements

15145 Implement Work Scope

1. Locate specific work areas
   a. Ability to:
      i. Review the work scope
      ii. Walk the job site
      iii. Find mechanicals
   b. Knowledge of:
      i. General construction
      ii. General mechanical knowledge
      iii. Job site specifics
      iv. Work scope
2. Verify access to work areas
   a. Ability to:
      i. Confirm approval for start of work
      ii. Work with crew chief to get access to areas
      iii. Remove obstructions for start of work
   b. Knowledge of:
      i. Work scope
      ii. General construction
      iii. Job site
      iv. Lifting safety
3. Install air sealing measures
   a. Ability to:
      i. Identify leaks and bypasses
      ii. Select materials
      iii. Look for code violations
      iv. Block large openings
      v. Hand seal gaps and cracks
      vi. Check tightness and durability of seal
   b. Knowledge of:
      i. Clearances
      ii. Fire code
      iii. Framing components

iv. Operation of a blower door
v. Use of tracer smoke
vi. Leakage sites
vii. Material capability
viii. Material durability
ix. Material strength
x. Penetrations
xi. Tolerances

4. Install loose fill insulation
   a. Ability to:
      i. Confirm air sealing is complete
      ii. Confirm exhaust fans are ducted to the outdoors and insulated
      iii. Confirm HVAC duct work is intact, sealed, supported, and insulated
      iv. Confirm clearance to combustibles
      v. Confirm clearance for electrical issues
      vi. Install baffles, blocking, platforms, and insulation dams
      vii. Install vertical insulation
      viii. Install horizontal insulation
      ix. Compare material use to coverage required (bags used)
   b. Knowledge of:
      i. Clearance
      ii. Combustibles
      iii. Component analysis
      iv. Coverage charts
      v. Depth markers
      vi. Duct requirements
      vii. General carpentry
      viii. How to draw a floor plan
      ix. Operation of a blower door
      x. Insulation installation requirements
      xi. Manufacturer's specifications for installation
      xii. Materials
      xiii. Rigid insulation board types
      xiv. R-values
      xv. Termination requirements
      xvi. Thermal barriers
5. Install or patch moisture barriers
   a. Ability to:
      i. Confirm positive drainage
      ii. Remove all organic/inorganic materials
      iii. Install moisture barrier and seal joints and seams
      iv. Verify flashing is installed

v. Identify and locate moisture sources
vi. Report bulk moisture concerns

b. Knowledge of:
i. Flashing locations
ii. Grading issues
iii. Gravity
iv. Installation standards
v. Materials
vi. Moisture problems
vii. Moisture symptoms
viii. Roof slope changes
ix. Where to look for moisture

6. Install ventilation
a. Ability to:
i. Uncrate equipment
ii. Remove old equipment
iii. Confirm electrical and plumbing requirements are in place
iv. Cut openings in building
v. Install venting system and vent terminations
vi. Install, air seal, and insulate ducting system
vii. Confirm installation is complete

b. Knowledge of:
i. Building science
ii. Equipment disconnects
iii. Equipment requirements
iv. Equipment shutoffs
v. Framing
vi. Conducting duct leakage testing
vii. Reading duct diagrams
viii. Manufacturer's specifications
ix. Penetration locations
x. Protection of materials
xi. Smoke testing joints
xii. Use of power tools
xiii. Utility knife safety

7. Install mechanical systems
a. Ability to:
i. Uncrate and verify equipment
ii. Remove old equipment
iii. Confirm electrical requirements are in place
iv. Confirm plumbing requirements are in place
v. Confirm fuel requirements are in place

vi. Cut openings in building
vii. Install equipment and renewable systems
viii. Install or reconnect return and distribution systems (hot water, steam, hydronic, forces air, etc.)
ix. Install, air seal, and insulate ducting system
x. Confirm installation is complete
xi. Connect or install combustion vent system

b. Knowledge of:
i. Cavity protection
ii. Circuit testers
iii. Circulating pumps
iv. Code requirements
v. Connectors
vi. Disconnects
vii. EPA safety
viii. Equipment requirements
ix. Flow
x. Flow through system
xi. Framing
xii. General carpentry
xiii. Locking joints
xiv. Insulation
xv. Leakage of ducts
xvi. Manufacturer's specifications
xvii. Mastics
xviii. Penetration locations
xix. Piping
xx. Protection of materials
xxi. Sheet metal
xxii. Shutoffs
xxiii. Slope
xxiv. System attachments
xxv. Temperature of conditioned space
xxvi. Use of power tools
xxvii. Utility knife safety

8. Commission equipment or systems
a. Ability to:
i. Verify all connections
ii. Verify operation
iii. Adjust to OEM specifications
iv. Report results

b. Knowledge of:

i. Design specifications
ii. Gas pressure tests
iii. Manufacturer's specifications
iv. OEM specifications
v. Types of materials for appliances

9. Confirm and ensure combustion safety
   a. Ability to:
      i. Check for safety issues, including ambient gas
      ii. Set up house for natural conditions
      iii. Run combustion equipment in proper sequence
      iv. Set up for and determine worst-case depressurization
      v. Check spillage, draft, and CO under worst-case depressurization
      vi. Report findings
   b. Knowledge of:
      i. Combustion safety testing
      ii. Draft testing
      iii. Natural conditions
      iv. Safety protocols
      v. Use of tools
      vi. Venting systems
      vii. Worst-case depressurization setup
10. Install dense pack insulation
   a. Ability to:
      i. Set up and tune machine for application
      ii. Locate insulation fill hole locations
      iii. Remove siding without damage
      iv. Confirm building component integrity
      v. Get access to all building cavities and locate all horizontal blocks
      vi. Check for hazards
      vii. Fill first cavity and confirm density stops air leakage
      viii. Readjust machine, if required
      ix. Fill all cavities
      x. Compare material use to coverage required (bags consumed)
      xi. Plug holes, patch weather barrier, replace siding, caulk joints
   b. Knowledge of:
      i. Basic math skills
      ii. Blower door testing
      iii. Building structures
      iv. Dense pack installation procedures
      v. Siding removal
      vi. Proper location for fill holes
      vii. Equipment

viii. Framing
ix. General carpentry
x. Hazards
xi. Probing the wall
xii. Limitations of components
xiii. Materials
xiv. Tracer smoke testing
xv. Strength of components
xvi. Testing procedures

11. Install windows and doors
    a. Ability to:
        i. Remove old windows and doors
        ii. Check and install waterproofing, flashing
        iii. Install windows and doors
        iv. Install air barrier and ensure proper water drainage
        v. Verify air tightness and drainage
    b. Knowledge of:
        i. Measurement accuracy up to 1/16 inch
        ii. Basic math skills
        iii. Building techniques
        iv. Building codes
        v. Building practices
        vi. Building science
        vii. Drainage planes
        viii. EPA lead safety
        ix. Fasteners
        x. Flashing techniques
        xi. General carpentry
        xii. Manufacturer's specifications
        xiii. Materials
        xiv. Pressure
        xv. Quality installations
        xvi. Vapor barriers/retarders
        xvii. Window and door types
12. Install electrical rough-in (fans)
    a. Ability to:
        i. Resolve hazards
        ii. Provide power to new equipment/appliance
        iii. Install or repair circuit
        iv. Install or repair lighting
        v. Install or repair controls
        vi. Seal penetrations and replace insulation

vii. Install systems, including photovoltaic

b. Knowledge of:
   i. Appliance requirements
   ii. Building codes
   iii. Building science
   iv. Circuitry
   v. Clearances
   vi. Efficiency
   vii. Fire codes
   viii. Local codes
   ix. Manufacturer's specifications
   x. Materials
   xi. National Electrical Code
   xii. Potential damage
   xiii. Trade-specific knowledge
   xiv. Wiring

13. Install plumbing
   a. Ability to:
      i. Remove old equipment
      ii. Resolve hazards
      iii. Provide hookups
      iv. Install or repair fixtures
      v. Install equipment including renewable systems
      vi. Seal penetrations and replace insulation
      vii. Check for draft
      viii. Install simple efficiency measures (low-flow fixtures, pipe wrap insulation)
      ix. Install advanced efficiency measures (hot water loop, on-demand water heaters)
   b. Knowledge of:
      i. Advanced plumbing knowledge
      ii. Asbestos
      iii. Basic carpentry
      iv. Combustion safety
      v. Brazing
      vi. Building codes
      vii. Building science
      viii. Combustible clearances
      ix. Domestic water heaters
      x. Drainage
      xi. Electrical
      xii. Fuel gas code
      xiii. Gas fitting

xiv. Gaskets
xv. Grading
xvi. Interior finish
xvii. Local hazards
xviii. Manufacturer's specifications
xix. Materials
xx. Pipe fitting
xxi. Pipe insulation
xxii. Piping
xxiii. Smooth wrench surfaces
xxiv. Tapes
xxv. Temperature requirements
xxvi. Venting
xxvii. Vermin hazards

14. Install roofing and flashing
    a. Ability to:
        i. Identify leak sources
        ii. Repair leak source
        iii. Remove roofing system
        iv. Install roofing system
        v. Insulate roof deck
        vi. Install attic venting
        vii. Flash new penetrations
    b. Knowledge of:
        i. Building science
        ii. Carpentry
        iii. Clearances
        iv. Debris control
        v. Drainage
        vi. Drainage plane
        vii. Fall protection
        viii. Fasteners
        ix. Flashing
        x. Gravity
        xi. Live load
        xii. Local building codes
        xiii. Manufacturer's specifications
        xiv. Materials
        xv. Math skills
        xvi. Product installations
        xvii. Roofing systems
        xviii. Tools

15. Clean as you go (organize)
    a. Ability to:
        i. Return tools to central area
        ii. Pick up material drops
        iii. Return belongings
        iv. Clean work area
    b. Knowledge of:
        i. Disposable materials
        ii. Dust containment
        iii. EPA lead safety
        iv. MSDS
        v. Safety knowledge
        vi. Safety requirements
        vii. Solvents
        viii. Tool inventory
        ix. Tool safety
16. Address deviations from work scope
    a. Ability to:
        i. Identify deviation
        ii. Report deviation
        iii. Request direction to modified work scope
        iv. Implement modified work scope
    b. Knowledge of:
        i. Work scope

15146 Wrap up

1. Pick up tools and materials
    a. Ability to:
        i. Inventory tools and materials used
        ii. Clean tools and materials
        iii. Store tools and materials
        iv. Report lost or broken items
    b. Knowledge of:
        i. Basic math skills
        ii. Manufacturer's specifications
        iii. Materials
        iv. Solvents
        v. Tool safety
        vi. Value of materials
2. Clean up an close out
    a. Ability to:

i. Break down protective barriers
ii. Pick up protective barriers
iii. Contain hazardous materials
iv. Contain and dispose of materials and waste
v. Dust, vacuum, mop, scrub, rake
vi. Restore occupant belongings
vii. Participate in final walk through inside and outside, including restoring mechanical systems
viii. Report to crew chief for final inspection

b. Knowledge of:
i. Disposal procedures
ii. EPA lead safety
iii. Hazardous materials
iv. Local codes
v. Local facilities
vi. MSDS
vii. Safe lifting practices
viii. Safety procedures
ix. Work scope

3. Participate in crew debriefing (post-weatherization job review)
a. Ability to:
i. Attend meeting
ii. Report awareness of deficient knowledge
iii. Report what when well and what went wrong
iv. Discuss homeowner concerns, complaints, and complements
v. Offer additional safety suggestions

b. Knowledge of:
i. Safety procedures
ii. Work scope

15150 Final Inspector

A final inspector is an evaluator who verifies the work performed against the work plan, specifications and standards, performs building diagnostics, records/reports findings and concerns, and specifies corrective actions; by conducting a methodological audit/inspection of the building, performing safety and diagnostic tests, and by observing the retrofit work; in order to ensure the completion, appropriateness and quality of the work providing for the safety, comfort, and energy savings of the building occupants.

15151 Conducting Final Inspections

1. Verify worker compliance with safety rules
a. Ability to:
i. Walk around the job site

ii. Observe the workers
iii. Observe the site conditions
iv. Interview the crew chief or subcontractor
v. Work in confined spaces

b. Knowledge of:
i. Basic construction knowledge
ii. Codes and standards adopted by local jurisdiction
iii. Relevant federal regulations (OSHA, EPA, DOE, etc.)
iv. First aid
v. Interview techniques

c. Skill in:
i. Communication
ii. Observation techniques

2. Assure worker professionalism
a. Ability to:
i. Conduct client interviews
ii. Evaluate the job site (trash, cleanliness)
iii. Verify that workers are familiar with their employer's code of conduct
iv. Observe the behavior of the workers

b. Knowledge of:
i. Awareness of the employer's requirements
ii. Knowledge of positive reinforcement techniques

c. Skill in:
i. Communication
ii. Observation
iii. Remaining tactful

3. Address work problems
a. Ability to:
i. Review the work against the work scope
ii. Observe worker skills
iii. Check materials being installed
iv. Observe sequencing of the components installed
v. Verify the condition and capacity of the equipment
vi. Determine need to conduct diagnostic tests
vii. Conduct diagnostic tests
viii. Document process issues and missed opportunities for change orders
ix. Revise work orders
x. Redirect weatherization work
xi. Discuss issues with crew chief
xii. Demonstrate proper methods to installers
xiii. Discuss missed opportunities with the energy auditor

b. Knowledge of:

i. Basic building science
ii. Codes and standards adopted by local jurisdiction
iii. Building materials
iv. Construction tools and use
v. Construction practices
vi. Documentation procedures
vii. Installation methods
viii. Standards and specifications
ix. Test procedures
x. Diagnostic tests

c. Skill in:
i. Communication
ii. Diplomacy
iii. Observation
iv. Training

4. Evaluate client satisfaction regarding the in-process work
a. Ability to:
i. Interview the client
ii. Observe client behavior
iii. Document findings
iv. Communicate findings to the crew chief or other responsible parties
b. Knowledge of:
i. Interview techniques
c. Skill in:
i. Communication
ii. Observation

15152 Conducting Final Inspections – Post-Work Visual/Sensory Inspections

1. Review client file and work scope
a. Ability to:
i. Review the energy audit report
ii. Review the work order
iii. Review the invoices or job completion report
iv. Review diagnostic test results provided by installers
v. Interpret diagnostic test results
vi. Interpret invoices
vii. Interpret work order
viii. Reconcile audit to work order to invoice
b. Knowledge of:
i. Program requirements
ii. Diagnostic procedures

iii. The energy audit process
iv. Job costing

2. Perform an exterior and interior visual/sensory inspection
   a. Ability to:
      i. Perform exterior and interior walk around inspection
      ii. Compare observations of exterior/interior to the client file information.
      iii. Verify installed components
      iv. Note any anomalies or missed opportunities or energy audit discrepancies
      v. Identify damage done by workers/subcontractors
      vi. Document non-compliance or exceptional work with camera
      vii. Identify additional building-specific diagnostic tests
   b. Knowledge of:
      i. Energy audit process
      ii. Basic building science
      iii. Building materials
      iv. Codes and standards adopted by local jurisdiction
      v. Construction work practices
      vi. Installation methods
      vii. Standards and specifications
      viii. Test protocols
      ix. Diagnostics tests
   c. Skill in:
      i. Analytical thinking
      ii. Basic math
      iii. Basic tool use
      iv. Observation
      v. Organization
3. Evaluate client satisfaction
   a. Ability to:
      i. Conduct client-specific interview to determine behavior changes, client education, comfort, satisfaction
      ii. Conduct program-specific interview to determine worker performance, process, scheduling, value, opportunities for worker improvement
      iii. Observe client behavior (thermostat setting, attire, window position, etc.)
      iv. Document client feedback
      v. Take corrective actions as necessary
   b. Knowledge of:
      i. Client education
      ii. Installed components
   c. Skill in:
      i. Communication
      ii. Listening
      iii. Mediation

iv. Observation
v. Remaining tactful

4. Determine pass/fail of work
   a. Ability to:
      i. Review results of visual/sensory inspection
      ii. Review results of diagnostic tests
      iii. Make a pass/fail determination
      iv. Obtain client signoff if passed
      v. Report inspection approval if passed
      vi. Identify work problems if failed
      vii. Generate a punch list if failed
   b. Knowledge of:
      i. Basic building science
      ii. Diagnostic thresholds
      iii. Codes and standards adopted by local jurisdiction
      iv. Standards and specifications
   c. Skill in:
      i. Making decisions
      ii. Being accurate
      iii. Analytical thinking
      iv. Attention to detail
      v. Remaining tactful

15153 Conducting Final Inspections – Post-Work Diagnostic Inspections

1. Conduct health and safety tests
   a. Ability to:
      i. Perform combustion safety tests (heating systems, water heaters, ovens, stoves, fireplaces)
      ii. Perform ventilation system tests
      iii. Conduct moisture evaluations
      iv. Conduct electrical safety tests
   b. Knowledge of:
      i. Codes and standards adopted by local jurisdiction
      ii. Combustion safety protocols
      iii. First aid
      iv. Heating systems
      v. Moisture issues
      vi. Safety issues
   c. Skill in:
      i. Analytical thinking
2. Conduct diagnostic tests
   a. Ability to:

i. Perform blower door tests
ii. Perform pressure pan tests
iii. Conduct zone pressure tests
iv. Conduct temperature rise test on furnaces
v. Conduct external static pressure test of furnaces
vi. Perform fan flow tests
vii. Perform infrared scans
viii. Perform duct leakage tests
ix. Perform appliance tests
x. Conduct domestic water heater temperature tests
xi. Record results of all tests

b. Knowledge of:
i. Basic building science
ii. Diagnostic testing procedures
iii. Manufacturer's specifications
iv. Program requirements

c. Skill in:
i. Attention to detail

3. Identify work problems

a. Ability to:
i. Review the results of all tests
ii. Compare results against field guide notes
iii. Compare results against pre-test data
iv. Compare results against work plan projections
v. Identify missed opportunities
vi. Determine deficiencies
vii. Target deficiencies for corrective actions
viii. Generate a punch list
ix. Make decisions
x. Read a flowchart

b. Knowledge of:
i. Basic building science
ii. Field guides
iii. Codes and standards adopted by local jurisdiction
iv. Standards and specifications
v. Testing protocols

c. Skill in:
i. Analytical thinking
ii. Communication

15154 Ensuring Worker Professionalism

1. Perform spot checks
   a. Ability to:
      i. Visit in-process job sites
      ii. Conduct random sampling of job-site documents
      iii. Conduct random sampling of worker credentials
      iv. Observe the workers
      v. Interview the client
      vi. Interview trade workers on job
      vii. Interview others at the job site
      viii. Ability to observe without interfering
   b. Knowledge of:
      i. Credentialing requirements for workers
      ii. Professional behavior and code of conduct
      iii. Program and agency guidelines
      iv. Required documentation
   c. Skill in:
      i. Attention to detail
      ii. Communication
      iii. Listening
      iv. Observation
      v. Remaining tactful
2. Provide feedback regarding professionalism
   a. Ability to:
      i. Document incidences of lack of professionalism
      ii. Document positive incidences of professionalism
      iii. Communicate with crew chief or appropriate part regarding professionalism incidences
      iv. Assure client of corrective measures
      v. Assist in training workers
   b. Knowledge of:
      i. Professional behavior and code of conduct
      ii. Required documentation
   c. Skill in:
      i. Remaining impartial
      ii. Communication

15155 Ensuring Program Compliance

1. Maintain professional credentials
   a. Ability to:
      i. Continue education and training

ii. Maintain professional licenses and/or certifications
iii. Maintain memberships in professional organizations
iv. Participate in industry activities

b. Knowledge of:
i. Licensure and certification requirements

2. Confirm the allocation of public funds
a. Ability to:
i. Review work orders
ii. Flag instances where work completed does not match funding requirements
iii. Guard against cost overruns
iv. Report disallowed costs

b. Knowledge of:
i. Work scopes
ii. Allowable activities under funding sources
iii. Maximum allowable caps on funding sources

c. Skill in:
i. Analytical thinking
ii. Attention to detail

3. Evaluate installed measures against the field guide, New Mexico Energy$mart Technical Standards, and State and local codes
a. Ability to:
i. Compare work completed with the accepted practices
ii. Identify work that does not meet accepted practices
iii. Determine if problem is material or labor related
iv. Suggest program changes
v. Recommend education for auditors and installers
vi. Aggregate information
vii. Identify gaps in training
viii. Clearly write a report

b. Knowledge of:
i. Basic building science
ii. Codes and standards adopted by local jurisdiction
iii. Industry standards
iv. Program requirements
v. Training curricula

c. Skill in:
i. Analytical thinking
ii. Remaining tactful

4. Close out the project
a. Ability to:
i. Ensure all punch-list items have been completed
ii. Assemble all required documentation (certificates, photos, etc.)

iii. Confirm all required signatures were obtained
iv. Prepare complete reports (checklists, required program reports, etc.)
v. Submit authorization for payments/reimbursements/invoices

b. Knowledge of:
i. Agency/program processes
ii. Program requirements
iii. Required paperwork
iv. Required signatures

c. Skill in:
i. Organization
ii. Report writing

5. Maintain files and records
a. Ability to:
i. Maintain job logs and notes in the files
ii. Maintain photos in the files
iii. Maintain information on any anomalies on the job
iv. Maintain information on any ongoing complaints
v. Maintain documentation from program monitoring (federal, state, utility)

b. Knowledge of:
i. Legal responsibilities
ii. Program requirements
iii. Recordkeeping practices

c. Skill in:
i. Attention to detail
ii. Organization

15160 Energy Educator

1. Competency:
a. Principles of adult education.
2. Possess a working knowledge of:
a. New Mexico Weatherization Standards.
b. The distinction between oral and print culture communication and when to use each to maximize the effects of client education.
c. The four models of energy conservation behavior and which is the most effective.
d. What actions can be taken to reduce energy use in the dwelling;
e. The basic steps of the weatherization process, from auditing, testing, installation, inspection, and monitoring.
f. The purpose of the basic equipment involved in weatherizing a dwelling, including a blower door, pressure pan, combustion analyzer, gas leak detector, insulation blowing machine, etc..
g. What actions need to be taken to maintain a healthy and safe indoor environment.

3. Demonstrate the ability to:
   a. Act as a public relations spokesperson for the meetings outside the agency, such as civic groups, senior centers and schools.
   b. Develop a trusting and professional relationship or partnership with the client.
   c. Explain why client education is important to the weatherization process.
   d. Explain what client education strategies work and why.
   e. Estimate the economic impacts of suggested actions to bolster customer commitment to changing their energy-related habits.
   f. Utilize a variety of resources and communication skills to achieve effective client education results.
   g. Assess the client's expectations of the WAP and help the client understand the program in an effort to reduce client complaints.
   h. Complete the Energy Partnership Plan with the client.
   i. Enhance a client's self-esteem with client education methods.

15200 Training and Certification of Program Personnel

New Mexico MFA will oversee the training and certification program for the Energy$mart Program personnel.

16000 Glossary

- A -

Abatement – A measure or set of measures designed to permanently eliminate a hazard (e.g., lead-based paint). Abatement strategies include removal of the hazardous materials, replacement of building components containing the hazardous material, enclosure, or encapsulation. All of these strategies require proper preparation, cleanup, waste disposal, post-abatement clearance testing, and if applicable, record keeping and monitoring. Abatement activities are not allowable expenses to be funded by Department of Energy Weatherization Assistance Program dollars.

Absorption – Absorption is the process by which a substance can be readily taken into the body through the skin or membranes. The best defense is to have a protective barrier between the substance and the skin.

Air Changes per Hour at 50 Pascals (ACH_{50}) – The number of times that the complete air volume of a home is exchanged for outside air in one hour when a blower door depressurizes or pressurizes the home to 50 Pascals.

Air Changes per Hour Natural (ACH_{nat}) – The number of times the indoor air is exchanged with the outdoor air in one hour under natural driving forces. It can be estimated using a blower door.

Air Exchange – The process whereby indoor air is replaced with the outdoor air through air leakage and ventilation.

Air-Free Carbon Monoxide – A measurement of CO in an air sample or flue gas that takes into account the amount of excess air (oxygen, O_2) in the sample, incorporating an adjustment to the as-measured CO ppm value, thus simulating air-free (oxygen-free) conditions in the sample. Usually measured in units of parts per million (ppm). See “As-Measured Carbon Monoxide.”

Air Handler – A steel cabinet containing a blower with cooling and/or heating coils connected to ducts, which circulates indoor air across the exchangers and into the habitable space.

Air Infiltration Barrier – A spun polymer sheet (for example, house wrap) that stops almost all the air traveling through a building cavity, while allowing moisture to pass through it.

Altitude Adjustment – The input modification for a gas appliance installed at a high altitude. When a gas appliance is installed more than 2000 feet above sea level, its input rating must be reduced by approximately four percent per 1000 feet above sea level.

Ambient Air – Air in the habitable space.

Ampere – A unit of measurement that tells how much electricity flows through a conductor. It is comparable to a cubic foot per second measurement of water flow. For example, a 1,200-watt, 120-volt hair dryer pulls 10 amperes of electric current (watts divided by volts).

AFUE – Annual Fuel Utilization Efficiency – A laboratory-derived efficiency for heating appliances that accounts for chimney losses, jacket losses, and cycling losses, but not distribution losses or fan/pump energy use.

Aquastat – A heating control that switches the burner or the circulator pump in a hydronic heating system.

Asbestos – A fibrous mineral with fireproof and insulation characteristics which may be shaped into a variety of building materials. Small, sharp, asbestos fibers may cause damage to lungs if they are inhaled.

ASHRAE – American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

As-Measured Carbon Monoxide – A measurement of CO in a sample of air or flue gas that does not take account of the amount of excess air (oxygen, O_2) diluting the CO concentration. Usually measured in units of parts per million (ppm). See "Air-Free Carbon Monoxide."

Atmospheric Burner – A burner utilizing *atmospheric combustion*.

Atmospheric Combustion – Combustion which takes place under *atmospheric pressure* at a given altitude.

Atmospheric Pressure – The weight of air and its contained water vapor on the surface of the earth. At sea level this pressure is 14.7 pounds per square inch.

- B -

Backdrafting – Continuous spillage of combustion gases from a vented combustion appliance into the conditioned space.

Backdraft Damper – A damper, installed near a fan, that allows air to flow in only one direction and prevents reverse flow when the fan is off.

Backer Rod – Polyethylene foam rope used as backing for caulking.

Baffle – A plate or strip designed to retard or redirect the flow of flue gases.

Balanced Flue Vent System – Term used for oil-fired systems to indicate a direct-vent appliance with positive pressure in the vent connector through which the gases of combustion pass.

Balance Point – The outdoor temperature at which no heating is needed to maintain inside temperatures.

Ballast – A coil of wire or electronic device that provides a high starting voltage for a lamp and limits the current flowing through it.

Balloon Framing – A method of construction in which the vertical framing members (studs) are continuous pieces, running the entire height of the wall.

Band Joist – See rim joist. Also known as “band board.”

Barometric Vent Damper – a device installed in the heating unit vent system to control draft. Usually used on oil-fueled units or gas units with power burners.

Batt – A blanket of preformed insulation, generally 14.5" or 22.5" wide, and varying in thickness from 3.5" to 9".

Belly Return – A configuration found in some mobile homes that uses the belly cavity as the return side of the heating/cooling distribution system.

Bimetal Element – A metal spring, lever, or disc made of two dissimilar metals that expand and contract at different rates as the temperature around them changes. This movement operates a switch in the control circuit of a heating or cooling device.

Blocking – A construction element or material used to prevent the movement of air or insulation into or through building cavities.

Blow-Down – Removing water from a boiler to remove sediment and suspended particulates.

Blower – The “squirrel-cage” fan in a furnace or air handler.

Blower Door – A calibrated device to measure the air tightness of a building by pressurizing or depressurizing the building and measuring the flow through the fan.

Blown Insulation – loose-fill insulation that is blown into attics and building cavities using an insulation blowing machine.

Boiler – A space heating appliance that heats water with hot combustion gases.

Boot – A duct section that connects between a duct and a register, floor, or wall cavity, or between round and square ducts.

Branch Circuit – An electrical circuit used to power outlets and lights within a home.

Breeching or Breech – See “Vent Connector.”

Brightness – The luminous intensity of any surface in a given direction per unit of projected area of the surface, as viewed in that direction.

British Thermal Unit (Btu) – The quantity of heat required at sea level to raise the temperature of one pound of water by one degree Fahrenheit.

Btuh – British thermal units per hour.

Building Cavities – The spaces inside walls, floors, and ceilings or between the interior and exterior sheeting.

Building Science – A complex perspective on buildings, using contemporary technology to analyze and solve problems of design, construction, maintenance, safety, and energy efficiency.

Burner – A device that facilitates the burning of a fossil fuel like gas or oil.

Bypass – An air leakage site that allows air to leak out of a building passing around the air barrier and insulation.

- C -

Carbon Dioxide (CO_2) – A heavy, colorless, nonflammable gas formed by the oxidation of carbon, by combustion, and by the respiration of plants and animals.

Carbon Monoxide (CO) – An odorless, colorless, tasteless, and poisonous gas produced by incomplete combustion.

Caulking – A mastic compound for filling joints and cracks.

Category I Fan-Assisted Gas Appliance – An appliance that operates with negative static pressure in the vent, a temperature that is high enough to avoid condensation in vent, and an integral fan to draw a controlled amount of combustion supply air through the combustion chamber. *Comment: Airtight vent connector is not required; induced combustion fan installed by manufacturer.*

Category I Gas Appliance – An appliance that operates with negative static pressure in the vent and a temperature that is high enough to avoid condensation in vent. *Comment: May be atmospheric or fan-assisted combustion; airtight vent connector is not required.*

Category II Gas Appliance – An appliance that operates with negative static pressure in the vent and a temperature that is low enough to cause excessive condensation in the vent. *Comment: No or very little equipment in this category.*

Category III Gas Appliance – An appliance that operates with positive static pressure in the vent and a temperature that is high enough to avoid condensation in vent. *Comment: Airtight vent connector; vented through the wall; forced draft.*

Category IV Gas Appliance – An appliance that operates with positive static pressure in the vent and a temperature that is low enough to cause excessive condensation in the vent. *Comment: Airtight vent connector; vented through the wall; forced draft; often referred to as a "90-plus" unit.*

CAZ – See Combustion Appliance Zone.

Cellulose Insulation – Insulation, packaged in bags for blowing, made from newspaper or wood waste, and treated with a fire retardant.

Chimney – A building component designed for the sole purpose of assuring combustion by-products are exhausted to the exterior of the building.

Central Return – System of ducts or passages for distribution return air, which connect different areas of the house to a central location at the forced air furnace.

Chimney Flue – A passageway in a chimney for conveying combustion gases to the outdoors.

Cleanout Opening – An opening in a chimney (usually at its base) to allows inspection and the removal of ash or debris.

Circuit Breaker – A device that automatically disconnects an electrical circuit from electricity under a specified or abnormal condition of current flow.

Coefficient of Performance (COP) – A heat pump or air conditioner output in Watt-hours of heat removed, divided by Watt-hours of electrical input.

Coil – A snakelike piece of copper tubing surrounded by rows of aluminum fins that clamp tightly to the tubing to aid in heat transfer.

Cold Air Return (return side): Ductwork through which house air is drawn for reheating during a furnace's cycle.

Color Rendering Index (CRI) – A measurement of a light source's ability to render colors the same as sunlight does. The CRI has a scale of 0 to 100.

Combustible – Susceptible to combustion; inflammable; any substance that will burn.

Combustible Gas Leak Detector – A device for determining the presence and general location of combustible gases in the air.

Combustion – The act or process of burning. Oxygen, fuel, and a spark must be present for combustion to occur.

Combustion Air – Air required to chemically combine with a fuel during combustion to produce heat and flue gases.

Combustion Analyzer – A device used to measure the steady-state efficiency of combustion heating units.

Combustion Appliance – Any appliance in which combustion occurs.

Combustion Appliance Zone (CAZ) – Room and enclosed air volume that contains a combustion appliance. This may include, but is not limited to, a mechanical room, mechanical closet, or main body of the house.

Combustion Chamber – The area inside a heating unit where combustion takes place.

Common Vent – The portion of the vent or chimney through which passes products of combustion from more than one appliance.

Compact Fluorescent Lamp (CFL) – A small fluorescent light engineered to fit conventional incandescent fixtures.

Compressor – A motorized pump that compresses a gaseous refrigerant and sends it to a condenser where heat is released.

Concentrically Constructed Direct-Vent – A direct-vent appliance that has an exhaust-gas vent and a combustion-supply-air vent arranged in a concentric fashion, i.e., one vent is inside the other with a space between the walls of each. *Comment: Mobile home furnace vents are usually constructed this way; some Category I, direct-vent water heaters are constructed this way.*

Condense – To change from a gaseous or vaporous state to a liquid or solid state by cooling or compression.

Condenser – The coil in an air conditioning system where the refrigerant condenses and releases heat, which is then carried away by air moving across the coil.

Condensate – The liquid formed when a vapor is condensed.

Condensate Receiver – A tank for catching returning condensate water from a steam heating system.

Conductance – The quantity of heat, in Btus, that will flow through one square foot of material in one hour, when there is a one degree Fahrenheit temperature difference between both surfaces. Conductance values are given for a specific thickness of material.

Conduction – The transfer of heat energy through a material (solid, liquid, or gas) by the motion of adjacent atoms and molecules without gross displacement of the particles.

Conductivity – The quantity of heat that will flow through one square foot of homogeneous material, one inch thick, in one hour, when there is a temperature difference of one degree Fahrenheit between its surfaces.

Confined Space – A space with a volume of less than 50 cubic feet per 1,000 Btu per hour of the total input rating of all combustion appliances installed in that space.

Control Circuit – A device that opens and closes a power circuit or opens and shuts a valve.

Convection – The transmission of heat by the actual movement of a fluid or gas because of differences in temperature, density, etc.

Conventionally Vented Combustion Appliance – Combustion appliances that are characterized by atmospheric burners or natural draft. Sealed or direct-vent appliances are not conventionally vented. Sometimes referred to as “open combustion.”

Cooling Load – The maximum rate of heat removal required of an air conditioner when the outdoor temperature and humidity are at the highest expected level.

Cost-Effective – Having an acceptable payback, return-on-investment, or savings-to-investment ratio.

Critical Framing Juncture – An intersection of framing members and envelope components that require special attention during prep and installation of insulation.

Cross Section – A view of a building component drawn or imagined by cutting through the component.

CFM – Cubic Feet per Minute – A measurement of air movement in cubic feet per minute past a certain point or through a certain structure.

CFM_{50} – The number of cubic feet per minute of air flowing through the fan housing of a blower door when the house pressure is 50 Pascals (0.2 inches of water column). This figure is the most common and accurate way of comparing the tightness of buildings that are tested using a blower door.

CFM_{nat} – The number of cubic feet of air flowing through a house from indoors to outdoors during typical, natural conditions. This figure can be roughly estimated using a blower door using the LBL (Lawrence Berkeley Labs) infiltration model.

- D -

Degree-days (DD) – A measure of outdoor temperature produced by summing the temperature differences between the inside (65°F) and the daily average outside temperature for a one-year period.

Demand – The peak need for electrical energy.

Density – The weight of a material divided by its volume, usually measured in pounds per cubic foot.

DOE – The United States Department of Energy.

Depressurize – To lower the pressure in an enclosed area with respect to a reference pressure.

Depressurization Tightness Limit (DTL) – A calculation, expressed in units of CFM_{50}, to estimate the building tightness level at which combustion appliances might backdraft when the house is under conditions of worst-case depressurization. A BDL must be selected for the calculation of the DTL. The DTL sets a low limit for air sealing that may or may not be lower than the building tightness limit for the same house.

Design Temperature – A high or low temperature used for designing heating and cooling systems when calculating the building load.

Dilution Air – Air that enters through an opening where the chimney joins to an atmospheric-draft combustion appliance.

Dilution Device – A draft diverter, draft hood, or barometric draft control on an atmospheric-draft combustion appliance.

Direct-Vent Appliance – A combustion appliance for which all combustion gases are vented to the outdoors through an exhaust vent pipe and all combustion supply air is vented to the combustion chamber from the outdoors through a separate, dedicated supply-air vent. *Comment: Most direct-vent gas appliances are Categories III and IV, but some are Category I; some direct-vent appliances utilize "Concentrically Constructed Direct-Vent".*

Distribution System – A system of pipes or ducts used to distribute energy.

DHW – Domestic Hot Water

Dormer – A framed structure projecting above a sloping roof surface, and normally containing a vertical window.

Downdraft – Air flowing down a chimney or vent during the appliance off-cycle.

Draft – A pressure difference that causes combustion gases or air to move through a vent connector, flue, chimney, or combustion chamber. May be *natural draft*, *induced draft*, or *forced draft*. Draft is often measured with a draft gauge (manometer or pressure gauge).

Draft Diverter – See "Draft Hood".

Draft Fan – A mechanical fan used in a venting system to augment the natural draft in gas- and oil-fired appliances. These electrically operated, paddle-fan devices are installed in vent connectors.

Draft Hood – A nonadjustable device built into an appliance or a part of the vent connector that is intended to 1) provide for escape of flue gases if blockage or backdraft occurs, 2) prevent a downdraft of outdoor air from entering the appliance, 3) neutralize the effect of stack action of the chimney, and 4) lower the dew point temperature of the flue gas by the infusion of ambient room air.

Draft Regulator – A self-regulating damper attached to a chimney or vent connector for the purpose of controlling draft. A draft regulator can reduce draft; it cannot increase draft.

Drywall – Gypsum interior wallboard used to produce a smooth and level interior wall surface and to resist fire. Also called gypsum wallboard and sheetrock.

Dry Bulb Temperature – Normal ambient air temperature measured by a thermometer.

Duct Blower – A blower door-like device used for testing duct leakiness and airflow.

Duct Zone – A building space or cavity that contains heating or cooling ducts.

- E -

Eave – The part of a roof that projects beyond its supporting walls. See also soffit.

Efficiency – The ratio of output divided by input.

Efficacy – The number of lumens produced by a watt used for lighting a lamp. Used to describe lighting efficiency.

Electric Service – The electric meter and main switch, usually located outside the building.

Emittance – The rate that a material emits radiant energy from its surface. Also called emissivity.

Encapsulation – Any covering or coating that acts as a barrier between the hazard (e.g., lead-based paint) and the environment, the durability of which relies on adhesion and the integrity of existing bonds between existing layers (e.g., paint) and the substrate.

Enclosure – The building shell. The exterior walls, floor, and roof assembly of a building. Also referred to as building envelope.

Energy – A quantity of heat or work.

Energy Audit – The process of identifying energy conservation opportunities in buildings.

Energy Consumption – The conversion or transformation of potential energy into kinetic energy for heat, light, electricity, etc.

Energy Efficiency – Term describing how efficiently a building component uses energy.

Energy Efficiency Ratio (EER) – A measurement of energy efficiency for room air conditioners. The EER is computed by dividing cooling capacity, measured in British Thermal Units per hour (Btuh), by the watts of power. (See also Seasonal Energy Efficiency Rating – SEER)

Envelope – The building shell. The exterior walls, floor, and roof assembly of a building. Also referred to as building enclosure.

Evaporation – The process of being changed into a vapor or gas at a temperature usually below the boiling point. Evaporation is a cooling process.

Evaporative Cooler – A device for cooling homes in dry climates. Cools the incoming air by the evaporation of water.

Evaporator – The heat transfer coil of an air conditioner or heat pump that cools the surrounding air as the refrigerant inside the coil evaporates and absorbs heat.

Exfiltration – Air flowing out of a building from its conditioned space through holes, leaks, or cracks in the shell.

- F -

Fahrenheit – A temperature scale for which water boils at 212° and freezes at 32°.

Fan-Assisted Combustion – A combustion appliance with an integral fan to draw combustion supply air through the combustion chamber. *Comment: Category I fan-assisted gas furnaces utilize this method of combustion control.*

Fan Control – A bimetal thermostat that turns the furnace blower on and off as it senses the presence of heat.

Fan-Off Temperature – In a furnace, the supply air temperature at which the fan control shuts down the distribution blower.

Fan-On Temperature – In a furnace, the supply air temperature at which the fan control activates the distribution blower.

Feeder Wires – The wires connecting the electric meter and main switch with the main panel box indoors.

Fenestration – Window and door openings in a building's wall.

Fiberglass – A fibrous material made by spinning molten glass.

Fill Tube – A plastic or metal tube used for its stiffness to blow insulation inside a building cavity and allow the insulation to be delivered at the extreme ends of the cavity.

Fire Stop – Framing member, usually installed horizontally between studs, designed to stop the spread of fire within a wall cavity.

Forced Draft – A vent system for which a fan installed at the combustion appliance moves combustion gases to the outdoors with positive static pressure in the vent pipe. Because of this positive pressure, the vent connector must be air-tight. *Comment: Normally Category III or IV appliances; usually no draft diverter or barometric damper; fan for venting combustion gases at or near appliance; usually vented through the wall; may be condensing.*

Furnace – A space heating appliance that heats air with hot combustion gases.

Furring – Thin wood strips fastened to a wall or ceiling surface as a nailing base for finish materials.

Flame Safety Control – A device that prevents fuel delivery in the event the ignition does not work.

Flammable/Inflammable – Combustible; readily set on fire.

Flashing – Waterproof material used to prevent leakage at intersections between the roof surface at walls or penetrations.

Floor Joists – The horizontal framing members that support the floor.

Flue – A vent for combustion gases.

Foam Board – Plastic foam insulation manufactured most commonly in 4' x 8' sheets in thicknesses of ½" to 3".

Foot-Candle – A measure of light striking a surface.

Footing – The part of a foundation system that transfers the weight of the building to the ground.

Friable –Easily broken into small fragments or reduced to powder, e.g., as with asbestos.

Frost Line – The maximum depth of the soil where water will freeze during the coldest weather.

Furnace – A space heating appliance that heats air with hot combustion gases.

- G -

Gable – The triangular section of an end wall formed by the pitch of the roof.

Gable Roof – A roof shape that has a ridge at the center and slopes in two directions.

GAMA – Gas Appliance Manufacturers' Association.

Gas Oven Bake Burner – Oven burner used for baking located just below the oven compartment floor.

Gas Oven Broiler Burner – Oven burner used for broiling located at the top of the oven compartment.

Gasket – Elastic strip that seals a joint between two materials.

Glazing – Glass installation. Pertaining to glass assemblies or windows.

Glazing Compound – A flexible, putty-like material used to seal glass in its sash or frame.

Ground Fault Circuit Interrupter (GFI or GFCI) – An electrical connection device that breaks a circuit if a short occurs. These are required for all exterior use of electrical equipment, or when an electrical outlet is located near a water source.

Gypsum Board – A common interior sheeting material for walls and ceilings, made of gypsum rock powder, packed between two sheets of heavy building paper. Also called sheetrock, gyprock, or gypboard.

- H -

Habitable Space – A building space intended for continual human occupancy. Examples include areas used for sleeping, dining, and cooking, but not bathrooms, toilets, hallways, storage areas, closets, or utility rooms. See occupiable space and conditioned space.

Hazardous Condition – A situation that is causing a danger to the client/crew/contractor that exists before, is created by, or is exacerbated by, weatherization. For example, a dwelling could have a moisture problem that is allowing biological hazards (molds, viruses, bacteria, etc.) to flourish. Another example would be fiberglass to entering the conditioned space due to improperly fastened or sealed ductwork.

Hazardous Material – A particular substance that is considered a danger to the client or crew.

Heat Anticipator – A very small electric heater in a thermostat that causes the thermostat to turn off before room temperature reaches the thermostat setting, so that the house does not overheat from heat distributed after the burner shuts off.

Heat Capacity – The quantity of heat required to produce a degree of temperature change.

Heat Exchanger – The device in a heating unit that separates the combustion chamber from the distribution medium and transfers heat from the combustion process to the distribution medium.

Heat Loss – The amount of heat escaping through the building shell during a specified period.

Heat Pump – A type of heating/cooling unit, usually electric, that uses a refrigerant fluid to heat and cool a space.

Heat Rise – In a furnace, the number of degrees of temperature increase that air is heated as it is blown over the heat exchanger. Heat rise equals heated air temperature minus air return temperature.

Heating Degree Day (HDD) – Each degree that the average daily temperature is below the base temperature (usually 65°F) constitutes one heating degree day.

Heating Load – The maximum amount of heat needed by a building during the very coldest weather to maintain the desired inside temperature.

Heating Seasonal Performance Factor (HSPF) – Rating for heat pumps describing how many Btus they transfer per kilowatt-hour of electricity consumed.

HVAC – Heating, Ventilating, Air-Conditioning.

High Limit – A bimetal thermostat that turns the heating element of a furnace off if it senses a dangerously high temperature.

Hip Roof – A roof with two or more contiguous slopes, joined along a sloping “hip.”

Home Energy Index – The number of Btus of energy used by a home, divided by its area of conditioned square feet and by the number of heating degree days during one year.

HVI – Home Ventilating Institute.

HWAP – Home Weatherization Assistance Program.

House Pressure – The difference in pressure between the inside and outside of the house.

HUD – United States Department of Housing and Urban Development.

Humidistat – An automatic control that switches a fan, humidifier, or dehumidifier on and off based on the relative humidity at the control.

Humidity Ratio – The absolute amount of air's humidity measured in pounds of water vapor per pound of dry air.

Hydronic System – A heating system using hot water or steam as the heat transfer medium. Commonly called a hot-water heating system.

- I -

IAQ – Indoor Air Quality

Inaccessible Cavity – An area that is too confined to enter and/or maneuver in by an average installer/mechanic.

Incandescent light – The common light bulb found in residential lamps and light fixtures and sold in stores everywhere and is known for its inefficiency.

Inches of Water Column (IWC) – A non-metric unit of pressure difference. One IWC is equal to about 0.004 Pascals.

Induced Combustion – See "Fan-Assisted Combustion".
Induced Draft – A vent system for which a fan – installed at or very near the termination point of the vent pipe – moves the combustion gases to the outdoors with negative static pressure in the vent pipe. *Comment: Normally Category I appliances; fan for venting combustion gases at point of exit to outdoors); vented through the wall.*

Induced Draft – A vent system for which a fan – installed at or very near the termination point of the vent pipe – moves the combustion gases to the outdoors with negative static pressure in the vent pipe. *Comment: Normally Category I appliances; fan for venting combustion gases at point of exit to outdoors); vented through the wall.*

Infiltration – The uncontrolled movement of non-conditioned air into a conditioned air space.

Infrared – Pertaining to heat rays emitted by the sun or warm objects on earth.

Input Rating – The designed capacity of an appliance, usually specified in Btus or units of energy.

Isolated Outdoor Air Supply – Term used with oil-fired systems to indicate a vent pipe through which outdoor combustion supply is ducted to the oil burner. *Comment: Often added on-site, these non-airtight outdoor air supply vents are sometimes installed with a vacuum relief damper that allows all the combustion supply air to be taken from the CAZ if the outdoor air inlet becomes blocked.*

Insulating Glass – Two or more glass panes spaced apart and sealed in a factory, and having a higher R-value than a single pane of glass.

Insulation – A material used to retard heat transfer.

Intermittent Ignition Device (IID) – A device that lights the pilot light on a gas appliance when the control system calls for heat, thus saving the energy wasted by a standing pilot.

Internal Gains – The heat generated by bathing, cooking, and operating appliances. At times, internal heat gains must be removed during the summer to promote comfort and they can reduce the heating demand in the winter.

Interstitial Space – Space between framing and other building components.

- J -

Joist – A horizontal wood framing member that supports a floor or ceiling.

Joule – A unit of energy. One thousand joules equals one Btu.

- K -

Kilowatt – One thousand watts. A unit of measurement of the amount of electricity needed to operate given equipment.

Kilowatt-Hour – The most commonly used unit for measuring the amount of electricity consumed over time; one kilowatt of electricity supplied for one hour.

Kinetic Energy – Consisting of, or depending on, motion; distinguished from potential energy.

- L -

Lamp – A light bulb.

Latent Heat – The amount of heat energy required to change the state of a substance from a solid to a liquid or from a liquid to a gas, without changing the temperature of the substance.

Lath – A support for plaster, consisting of thin strips of wood, metal mesh, or gypsum board.

Lead Safe Work Practices – Work practices required by the DOE for pre-1978 homes when the weatherization work will disturb more than two square feet of painted surface in an interior room, 10% of a small component such as a baseboard or door casing, and/or when the work will disturb more than twenty square feet of painted exterior surface.

Light Quality – The relative presence or absence of glare and brightness contrast. Good light quality has no glare and low brightness contrast.

Living Space Return System – In a mobile home, a forced warm air circulation system where air returns to the air handler through the living space, rather than through ductwork or through the mobile home belly.

Local Ventilation – A term used in ASHRAE Standard 62.2 that refers to ventilation serving bathrooms and kitchens, as contrasted with whole-building ventilation. Local ventilation is intended to exhaust odors and moisture at their source and thereby enhance the indoor air quality.

Low-Water Cutoff – A float-operated control for turning the burner off in a steam or hot water boiler if low on water.

Lumen – A unit of light output from a lamp.

Low-E – Short for “low emissivity”, which refers to having a metallic glass coating to resist the flow of radiant heat.

- M -

Main Panel Box – The electric service box containing a main switch, and the fuses or circuit breakers located inside the home.

Make-Up Air – Air supplied to a space to replace exhausted air.

Manifold – A tube with one inlet and multiple outlets, or multiple inlets and one outlet.

Manometer – A differential gauge used for measuring pressure.

Manufactured Home – A mobile home or a “double-wide” structure.

Masonry – Stone, brick, or concrete block construction.

Mastic – A thick, creamy substance used to seal seams and cracks in building materials, and especially useful on ductwork.

Mechanical Draft – A combustion appliance with induced draft of forced draft.

MFA – New Mexico Mortgage Finance Authority.

MHEA – Manufactured Housing Energy Audit, developed by the Department of Energy for weatherization assistance programs. Used to audit mobile homes.

Mitigate – To make less severe.

Mortar – A mixture of sand, water, and cement used to bond bricks, stones, or blocks together.

MSDS – Materials Safety Data Sheet.

- N -

Natural Draft – A vent system that relies on natural draft (buoyant air) to move combustion gases to the outdoors. *Comment: Category I appliances; atmospheric, fan-assisted, or power burner type combustion; sometimes direct-vent; might be through-the-wall vented.* (Based on NFPA 54)

Natural Ventilation – Ventilation using only natural air movement, without fans or other mechanical devices.

NBS – The National Bureau of Standards, renamed by the Department of Commerce as the National Institute of Standards and Technology (NIST).

NEMA – National Electrical Manufacturers' Association

NEAT – National Energy AudiT, developed by the Department of Energy for weatherization assistance programs. Used to audit single-family and low-rise multi-family buildings.

NFPA – National Fire Protection Association.

Net Free Vent Area (NFVA) – The area of a vent, adjusted for the restrictions caused by insect screen, louvers, and weather coverings. The free area is always less than the actual area.

Nozzle – An orifice designed to change a liquid like oil into a mist to improve the combustion process.

- O -

O_2 – Oxygen.

Occupants – People of any age living in a dwelling. Animals are not defined as occupants.

Occupiable Space – An enclosed space inside the pressure boundary of a room or house, and intended for human activities including, but not limited to, all habitable spaces, bathrooms, closets, halls, storage and utility areas, and laundry areas. See habitable space and conditioned space.

Ohm – A unit of measure of electrical resistance. One volt can produce a current of one ampere through a resistance on one ohm.

Open-Combustion Appliance - A combustion appliance that takes its combustion supply air from the surrounding room. Contrast this with direct-vent or sealed combustion appliance.

Orifice - A hole in a nozzle where gas exits to be mixed with air in a burner before combustion in a heating device. The size of the orifice will help determine the flow rate.

Output Capacity - The useful heat or work that a device produces after accounting for the energy wasted in the energy conversion process.

Oxygen Depletion Sensor (ODS) - A safety device for unvented (vent-free) combustion heaters that shuts off gas when oxygen is depleted.

- P -

Parts per Million (ppm) - The unit commonly used to represent the degree of pollutant concentration, where the concentrations are small.

Pascal (Pa) - A metric unit of measurement of air pressure. 2.5Pa = 0.01 inches of water column.

Payback Period - The number of years that an investment in energy conservation will take to repay its cost in energy savings.

Perimeter Pull - A technique used in attics previously insulated with batt insulation. The batts are cut back two feet from the eaves and the area is insulated with blown insulation to ensure coverage over the outer wall top plate, and to prevent wind washing of the insulation under the existing batts.

Perlite - A heat-expanded mineral used for insulation.

Perm - A measurement of how much water vapor a material will let pass through it, per unit of time, under a specified pressure difference.

Plaster - A mixture of sand, lime, and Portland cement spread over wood or metal lathe to form the interior surfaces of walls and ceilings.

Plate - A framing member installed horizontally to which the vertical studs in a wall frame are attached.

Plenum - The section of ductwork that connects the air handler to the main supply duct.

Plywood - Laminated wood sheeting with layers cross-grained to each other.

Poly isocyanurate - Plastic foam insulation sold in sheets, similar in composition to polyurethane.

Polystyrene Insulation - rigid plastic foam insulation, usually white, blue, pink, or green in color.

Polyurethane - versatile plastic foam insulation, usually yellow in color.

Potential Energy – Energy in a stored or packaged form.

Power Burner– A burner for which air is supplied at a pressure greater than atmospheric pressure. Most oil–fired burners are power burners. Gas burners used to replace oil burners are usually power burners.

Power Draft – See “Mechanical Draft”.

Pressure – A force that encourages movement by virtue of a difference in some condition between two areas. High pressure moves to low pressure.

Pressure Diagnostics – The practice of measuring pressures and flows in buildings to control air leakage, and to ensure adequate heating, cooling, and ventilation.

Pressure Pan – A device used to block a duct register while measuring the pressure behind it.

Pressure Relief Valve – A safety component required on a boiler and water heater, designed to relieve excess pressure buildup in the tank.

Pressuretrol – A control that turns a steam boilers burner on and off as steam pressure changes.

Primary Window – The main window installed on the outside wall. Not to be confused with a storm window.

- R -

R–value – A measurement of thermal resistance.

Radiant Barrier – A foil sheet or coating designed to reflect radiant heat flow. Radiant barriers are not mass insulating materials.

Radiant Temperature – The average temperature of objects in a home, including walls, ceiling, floor, furniture, and other objects.

Radiation – Heat energy that is transferred by electromagnetic energy or infrared light, from one object to another. Radiant heat can travel through a vacuum and other transparent materials.

Radon – A radioactive gas that decomposes into radioactive particles.

Rafter – A beam that gives form and support to a roof.

Reflectance – The ratio of lamination or radiant heat reflected from a given surface to the total light falling on it. Also called reflectivity.

Refrigerant – Any of various liquids that vaporize at a low temperature, used in mechanical refrigeration.

Register – A grille covering a duct supply outlet used to diffuse the airflow and sometimes control the flow.

Relative Humidity – The percent of moisture present in the air compared to the maximum amount possible at that given temperature. Air that is saturated has 100% relative humidity.

Relay – An automatic, electrically operated switch.

Reset Controller – A device that adjusts fluid temperature or pressure in a central heating system according to outdoor air temperature.

Resistance – The property of a material resisting the flow of electrical energy or heat energy.

Retrofit – An energy conservation measure that is applied to an existing building. Also, the action of improving the thermal performance or structural condition of a building.

Return Air – Air circulating back to the furnace or central air conditioning unit from the house, to be heated or cooled and supplied back to the living area.

Rim Joist – The outermost joist around the perimeter of the floor framing. Also known as “band joist” or “band board”.

Rocking on the High Limit – Refers to the gas burner being shut down by the high limit switch on a furnace, instead of being properly activated by the fan-on/fan-off control.

Room Air Conditioner – An air conditioning unit installed through a wall or window, which cools the room by removing heat and releasing it outdoors.

- S -

Sash – A movable or stationary part of a window that frames a piece of glass.

Savings-to-Investment Ratio (SIR) – For an energy saving measure, the ratio of the savings divided by the investment (cost), including the discounted investment value and escalation of fuel costs. See SIR below.

SIR – Savings-to-Investment Ratio. The SIR value of an energy-saving measure should be at least one for it to be installed. The Life of a measure is discounted with factors published by the Department of Energy every April.

Sealed-Combustion Appliance – An appliance that draws combustion air from outdoors and has a sealed exhaust system. Also called a direct-vent appliance.

Seasonal Energy Efficiency Ratio (SEER) – A measurement of energy efficiency for central air conditioners. The SEER is computed by dividing cooling capacity, measured in Btuh, by the Watts (see also Energy Efficiency Rating).

Sensible Heat – The heat required to change the temperature of a material without changing its form.

Service Wires – The wires coming from the utility transformer to the service equipment of the building.

Shall – For the purposes of this Standard, the word “shall” means the action is required. If, for any reason, a required act or task cannot be done, the reasons must be documented in the client file.

Sheathing – Structural sheeting, attached on top of the framing, underneath the siding and roofing of a building. Any building material used for covering a building surface.

SHPO – State Historic Preservation Office.

Sheetrock – See drywall.

Shell – The building’s exterior envelope – the walls, floor, and roof of a building.

Shingle – A roofing component installed in overlapping rows.

Should – For the purposes of this Standard, the word “should” means the action is strongly recommended, but not required.

Short Circuit – A dangerous malfunction in an electrical circuit, where electricity is flowing through conductors and into the ground without going through an electric load, such as a light or motor.

Sill – The bottom of a window or doorframe.

Sill Box – The area bounded by the rim joist, floor joists, sill plate, and floor.

Site-Built Home – Includes a house built on the site from building supplies, or manufactured homes assembled on the site from pieces shipped to the site on flatbed trucks. Does not include mobile homes and double-wides.

Slope – The roof section of an attic with the roof and ceiling surfaces attached to the rafters.

Soffit – The underside of a roof overhang or a small lowered ceiling, as above cabinets or a bathtub.

Solar Gain – Heat from the sun that is absorbed by a building.

Solenoid – A magnetic device that moves a switch or valve stem.

Sone Level – An international unit used to measure sound levels. One Sone is equivalent to the sound of a quiet refrigerator in a quiet kitchen.

Space Heating – Heating the habitable spaces of the home with a room heater or central heating system.

Spillage – The temporary flow of combustion gases from a dilution device.

Stack Effect – The tendency for warm buoyant air to rise and leak out of the top of the house and be replaced by colder outside air entering from the bottom of the house.

Steady-State Efficiency (SSE) – The efficiency of a heating appliance, after an initial start-up period and while the burner is operating, that states how much heat crosses the heat exchanger. The steady-state efficiency is measured by a combustion analyzer.

Steam Trap – An automatic valve that closes to trap steam in a radiator until it condenses.

Steam Vent – A bimetal-operated vent that allows air to leave steam pipes and radiators, but closes when exposed to steam.

Stud – A vertical framing member used to build a wall.

Subfloor – The sheathing over the floor joists and under the flooring.

Supply Air – Air that has been heated or cooled and is then moved through the ducts and out the supply registers of a home.

Suspended Ceiling – Modular ceiling panels supported by a hanging frame.

- T -

Therm – A unit of energy equivalent to 100,000 Btus or 29.3 kilowatt-hours.

Thermal Break – A piece of relatively low-conducting material between two high conducting materials, installed to reduce heat flow through the assembly.

Thermal Bridging – Rapid heat conduction resulting from direct contact between thermally conductive materials like metal and glass.

Thermal Boundary – A ceiling/roof, wall, floor, window, or door that separates the habitable, occupiable, and conditioned spaces from the outdoor weather. The thermal boundary should be air sealed and/or insulated if it is cost effective to do so. Exterior doors are always examples of thermal boundaries. An attic floor is most often an example of a thermal boundary.

Thermal Bypass – An indirect penetration that tends to reduce the effectiveness of insulation by allowing conditioned air to move out of a structure, or allowing unconditioned air to move in.

Thermal Conductance – A material's ability to transmit heat; the inverse of the R-value (see U-factor).

Thermal Enclosure – The boundaries of a dwelling that serve envelop the space to be kept warm during cold weather and cool during warm weather. The surfaces of the thermal enclosure usually serve as a thermal and pressure barrier.

Thermal Resistance – R-value; a measurement expressing the ability to retard heat flow.

Thermocouple – A bimetal-junction electric generator used to control the safety valve of an automatic gas valve.

Thermostat – A device used to control a heating or cooling system to maintain a set temperature.

Through-the-Wall Vented – Combustion appliances that are vented through a wall rather than into a vertical-rise chimney or vent. Such appliances are usually Category III or IV, but might also be Category I (e.g., direct-vent Category I water heater).

Transformer – A double coil of wire that reduces or increases voltage from a primary circuit to a secondary circuit.

Truss – A braced framework usually in the shape of a triangle to form and support a roof.

Type IC recessed electrical fixture – An electrical fixture that is rated to be in direct contact with thermal insulation.

- U -

U-factor – The total heat transmission in Btus per square feet per hour with a 1°F temperature difference between the inside and the outside; the thermal conductance of a material.

Ultraviolet Radiation – Light radiation having wavelengths beyond the violet end of the visible spectrum; high frequency light waves.

Unconditioned Space – An area within the building envelope that is not heated or cooled, but tends to be the same temperature as outside.

Underlayment – Sheeting installed to provide a smooth, sound base for a finish material.

UL – Underwriter's Laboratory

- V -

Vapor Barrier – A material with a vapor permeance of one or less.

Vapor Diffusion – The flow of water vapor through a solid material.

Vapor Retarder – A material with a vapor permeance between one and 10.

Vaporize – To change from a liquid to a gas.

Vent Connector – The pipe that connects the combustion appliance to a vent or chimney.

Vent Damper – An automatic damper powered by heat or electricity that closes the chimney while a heating device is off.

Ventilation – The movement of air through an area to remove moisture, air pollution, or unwanted heat.

Venting – The removal of combustion gases by a chimney.

Venting System – A continuous passageway from a combustion appliance to the outdoors through which combustion gases can safety pass.

Vermiculite – A heat-expanded mineral used for insulation.

Volt – A unit of electromotive force. It is the amount of force required to drive a steady current of one ampere through a resistance of one ohm. Electrical systems of most homes in the United States have 120-volt systems.

- W -

Watt (W) – A unit measure of electric power at a point in time, as capacity or demand. One Watt of power maintained over time is equal to one joule per second.

Watt-hour – One Watt of power extended for one hour. One thousandth of a kilowatt-hour.

Weatherization – The process of reducing energy consumption and increasing comfort in buildings by improving the energy efficiency of the building and maintaining health and safety.

Weatherstripping – Flexible gaskets, often mounted in rigid metal strips, for limiting air leakage.

WAP – Weatherization Assistance Program.

Weep Holes – Drilled holes that allow water to drain out of an area of a building component where it may accumulate.

Wet Bulb Temperature – The temperature of a dampened thermometer of a sling psychrometer used to determine relative humidity.

Whole-Building Ventilation -- A term used in ASHRAE Standard 62.2 that refers to ventilation serving the entire living area, as contrasted with “local ventilation” which serves only bathrooms and kitchens. Whole-building ventilation is intended to provide fresh outdoor dilution air and thereby enhance the indoor air quality.

Window Films – Plastic films, coated with a metalized reflective surface that are adhered to window glass to reflect infrared rays from the sun.

Window Frame – The sides, top, and sill of the window, which form a box around window sashes and other components.

Worst-Case Depressurization – A condition created when 1) all exhaust appliances (bathroom exhaust, kitchen exhaust, vented dryers, etc.) are operating, 2) the interior doors of a house are in a position that causes the greatest negative pressure in the Combustion Appliance Zone, and 3) the furnace air handler is operating (if such operation causes increased negative pressure in the Combustion Appliance Zone).

Worst-Case Depressurization Test – A test that creates Worst-Case Depressurization in a Combustion Appliance Zone (CAZ). This test is used to determine if combustion appliances will vent properly under these worst-case conditions.